



(11)

EP 4 510 384 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
19.02.2025 Bulletin 2025/08

(51) International Patent Classification (IPC):
H01Q 1/52 ^(2006.01) **H01Q 5/10** ^(2015.01)
H01Q 1/38 ^(2006.01)

(21) Application number: **23851635.5**

(52) Cooperative Patent Classification (CPC):
H01Q 1/24; H01Q 1/38; H01Q 1/48; H01Q 1/50;
H01Q 1/52; H01Q 5/10

(22) Date of filing: **31.07.2023**

(86) International application number:
PCT/CN2023/110287

(87) International publication number:
WO 2024/032414 (15.02.2024 Gazette 2024/07)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(30) Priority: **12.08.2022 CN 202210970347**

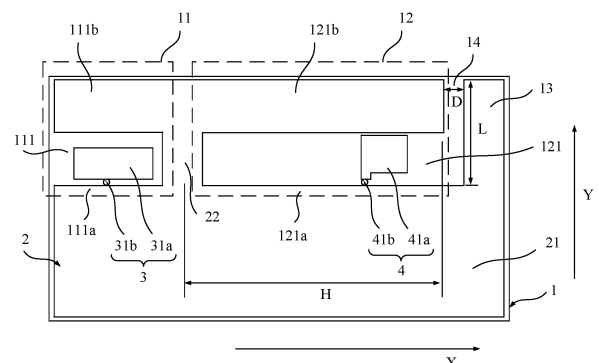
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(54) **ANTENNA AND TERMINAL DEVICE**

(57) This application provides an antenna and a terminal device. The antenna includes: a dielectric substrate and a conductor component at least partially disposed on the dielectric substrate. The conductor component is provided with a first half-open groove and a second half-open groove that do not connect to each other. A conductive stub is further disposed on a side that is of the conductor component and that is in an opening direction of the second half-open groove, a first end of the conductive stub is connected to a first side wall of the second half-open groove, and a slit is disposed between a second end of the conductive stub and a second side wall of the second half-open groove. A first feed structure is disposed in the first half-open groove. A second feed structure is disposed in the second half-open groove. A direction of a current that is on the conductive stub and that is coupled to the first feed structure through the first side wall of the second half-open groove is opposite to a direction of a current that is on the conductive stub and that is coupled to the first feed structure through the second side wall of the second half-open groove. In this way, reverse currents cancel each other, thereby improving an isolation between two antennas. In addition, the conductive stub is disposed on one side of the antenna, to

implement antenna miniaturization, thereby saving space.



Description

[0001] This application claims priority to Chinese Patent Application No. 202210970347.3, filed with the China National Intellectual Property Administration on August 12, 2022 and entitled "ANTENNA AND TERMINAL DEVICE", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to the field of communication technologies, and in particular, to an antenna and a terminal device.

BACKGROUND

[0003] Customer premises equipment (customer premises equipment, CPE) is a device that converts a long term evolution (Long Term Evolution, LTE) signal or a mobile communication network (New Radio, NR) signal received from a base station into a wireless fidelity (Wireless Fidelity, Wi-Fi) signal and then sends the signal for access of a user terminal, may support access of a plurality of mobile terminals simultaneously, and is widely used in places such as homes, hospitals, factories, shopping malls, and offices. Compared with a wired network, the customer premises equipment is more flexible in application scenarios and convenient for network construction.

[0004] However, with development of communication technologies, a multiple-input multiple-output (multiple-input multiple-output, MIMO) technology is widely applied to terminal products, and a quantity of antennas in the CPE increases. In view of this, how to deploy a plurality of antennas in limited space and ensure an isolation between the antennas becomes a key problem to be resolved.

SUMMARY

[0005] An objective of this application is to provide an antenna and a terminal device, to deploy a plurality of antennas in limited space of the terminal device and ensure an isolation between the antennas. A first aspect of this application provides an antenna, including:

a dielectric substrate;
a conductor component at least partially disposed on the dielectric substrate, where the conductor component is provided with a first half-open groove and a second half-open groove that do not connect to each other, and an opening direction of the first half-open groove and an opening direction of the second half-open groove are away from each other;
a conductive stub further disposed on a side that is of the conductor component and that is in the opening direction of the second half-open groove, where a

first end of the conductive stub is connected to a first side wall of the second half-open groove, and a slit is disposed between a second end of the conductive stub and a second side wall of the second half-open groove;

a first feed structure, disposed in the first half-open groove; and

a second feed structure, disposed in the second half-open groove.

[0006] When the antenna provided in this application operates in a low frequency band like 2 GHz to 2.5 GHz, and any feed structure performs feeding, reverse currents cancel each other at the other feed structure, so that two antennas are decoupled. In this way, an isolation between the two antennas is improved.

[0007] The antenna with the conductive stub that is provided in this application can cover low, intermediate, and high frequency bands of 2 GHz to 5 GHz, and there are a good isolation and a large decoupling bandwidth between antennas. Especially when the antenna operates in a low frequency band of 2 GHz to 2.5 GHz, and any feed structure performs feeding, reverse currents cancel each other in the other feed structure, so that two antennas are decoupled, and an isolation between the two antennas is improved. In addition, the antenna provided in this application is two antennas formed on one conductor component. The conductive stub is disposed on one side of one of the antennas to improve the isolation of the antennas. In addition, the slit is disposed between the conductive stub and only one antenna, and does not need to be disposed between two independent antennas and maintain a distance between both of the two antennas, as in a conventional decoupling structure. Therefore, the antenna provided in embodiments of this application can implement antenna size miniaturization, thereby reducing occupied space. This facilitates miniaturization of customer premises equipment and deployment of more antennas in limited space.

[0008] In a possible design, a first side wall of the second half-open groove is coupled to the first feed structure to generate a first current on the conductive stub, a second side wall of the second half-open groove is coupled to the first feed structure to generate a second current on the conductive stub, and a direction of the first current and a direction of the second current are opposite. In a possible design, the conductor component includes a ground part and a ground plane, the ground part is electrically connected to the ground plane, the first half-open groove and the second half-open groove are formed between the ground part and the ground plane, and the first half-open groove and the second half-open groove are separated by using the ground part.

[0009] The ground plane and the ground part each are a part of the conductor component. The ground part is a common part of the first half-open groove and the second half-open groove, and the first half-open groove and the second half-open groove are grounded by using the

ground part. Further, a part of the ground plane may serve as a first side wall of the first half-open groove and the first side wall of the second half-open groove. That is, the first half-open groove and the second half-open groove are formed on one conductor component, so that a first antenna formed at the first half-open groove and a second antenna formed at the second half-open groove may form an antenna. This helps reduce an overall size of the antenna, thereby reducing occupied space.

[0010] In a possible design, a length direction of the first half-open groove is the same as a length direction of the second half-open groove. The first half-open groove and the second half-open groove may extend in a same direction and be disposed adjacently. The ground part is interposed between the first half-open groove and the second half-open groove, and a width of the ground part in the extension direction of the first half-open groove and the second half-open groove is less than or equal to 6 mm, so that the antenna can be miniaturized, thereby reducing occupied space. In a possible design, the width of the ground part is less than or equal to 4 mm or less than or equal to 3 mm.

[0011] In a possible design, an electrical length between an end part of the second side wall of the second half-open groove and a center of the ground part is a quarter wavelength of a target frequency band of the antenna. In this way, an energy traction effect of the conductive stub is improved.

[0012] In a possible design, an extension direction of the conductive stub is perpendicular to the opening direction of the second half-open groove, and an electrical length of the conductive stub in the extension direction is less than or equal to the quarter wavelength of the target frequency band of the antenna. In this way, the energy traction effect of the conductive stub is improved.

[0013] In a possible design, an upper end face of the conductive stub is flush with an upper surface of the second side wall of the second half-open groove. The upper end surface of the conductive stub is flush with the upper surface of the second side wall of the second half-open groove, so that an optimal energy traction effect of the conductive stub can be achieved.

[0014] In a possible design, the conductive stub includes a first segment and a second segment, a first end of the first segment is connected to the first side wall of the second half-open groove, a second end of the first segment is connected to a first end of the second segment, and the slit is disposed between a second end of the second segment and the second side wall of the second half-open groove.

[0015] The conductive stub may be in an L shape, so that a height of the conductive stub above the ground plane and a width of the slit may be adjusted by adjusting a length of the first segment and a length of the second segment. In this way, when the first antenna and the second antenna form different types of antennas, an optimal energy traction effect can be achieved.

[0016] In a possible design, a sum of an electrical

length of the first segment and an electrical length of the second segment is less than or equal to the quarter wavelength of the target frequency band of the antenna. In this way, the non-straight-line conductive stub can have a better energy traction effect.

[0017] In a possible design, the first feed structure includes a first coupling piece, the first coupling piece is disposed in the first half-open groove, and the first coupling piece is provided with a first feed point.

[0018] The conductor component may be fed by using the first feed point and the first coupling piece, and a slot is formed between a surrounding edge of the first coupling piece and a corresponding side wall of the first half-open groove, to form a coupling feed structure. In this way, a current can be evenly distributed on the ground plane, and a better bandwidth and omnidirectional radiation characteristic are provided.

[0019] In a possible design, the first feed structure includes a first feed member, a first end of the first feed member is provided with a first feed point, and a second end of the first feed member is connected to a second side wall of the first half-open groove.

[0020] The first feed member is directly connected, for example, welded, to the second side wall of the first half-open groove. Certainly, the first feed member and the second side wall of the first half-open groove are of an integrated structure, that is, the first feed member is also a part of the conductor component. A structure form in which the first feed member directly bridges the two corresponding side walls of the first half-open groove is used, so that the first antenna forms an IFA antenna. In this embodiment, the second side wall of the first half-open groove may be directly fed by using the first feed member, thereby facilitating simplification of an overall structure of the antenna.

[0021] In a possible design, the second feed structure includes a second coupling piece, the second coupling piece is disposed in the second half-open groove, and the second coupling piece is provided with a second feed point.

[0022] In a possible design, the second feed structure includes a second feed member, a first end of the second feed member is provided with a second feed point, and a second end of the second feed member is connected to the second side wall of the second half-open groove.

[0023] The second feed member and the first feed member may have a same structure form and technical effect, and details are not described herein again. The first feed member and the second feed member each may be a feeder. When both the first antenna and the second antenna are fed in a form of a feeder, both the first antenna and the second antenna form an IFA antenna.

[0024] In a possible design, the dielectric substrate is provided with a feed circuit, and both the first feed point and the second feed point are connected to the feed circuit, so that the conductor component can be fed by using the feed circuit.

[0025] In a possible design, the conductor component

and the feed circuit are located on a same side of the dielectric substrate, so that the feed circuit, the first antenna, and the second antenna are all disposed on a same side of the dielectric substrate, and there is no need to process a back of the dielectric substrate, for example, by copper covering, or disposing a metal via or a waveguide, thereby helping reduce an overall volume of the antenna and simplify a structure.

[0026] In a possible design, a width of the slit is greater than or equal to 1 mm. In this way, the conductive stub can improve an isolation during operation of the antenna in a low frequency band of 2 GHz to 2.5 GHz.

[0027] In a possible design, a width of the slit is 1 mm to 4 mm. In this width range, an isolation in a frequency band of 2 GHz to 2.5 GHz can be effectively improved.

[0028] In a possible design, the conductor component is of an integrated structure, that is, the first half-open groove, the second half-open groove, the ground part, the ground plane, and the conductive stub are all formed on one conductor component, so that an antenna size can be miniaturized, thereby reducing occupied space. This facilitates miniaturization of customer premises equipment and deployment of more antennas in limited space.

[0029] A second aspect of this application further provides a terminal device, including the foregoing antenna.

[0030] In a possible design, the terminal device includes a metal frame, a conductor component includes a ground plane, the ground plane is disposed on a dielectric substrate, a first half-open groove and a second half-open groove are formed between the ground plane and the metal frame, and the metal frame forms a second side wall of the first half-open groove and a second side wall of the second half-open groove.

[0031] In a possible design, the terminal device includes a housing, the antenna is disposed inside the housing, and the conductor component is completely disposed on the dielectric substrate.

[0032] It should be understood that the foregoing general descriptions and the following detailed descriptions are merely used as an example, and should not limit this application.

BRIEF DESCRIPTION OF DRAWINGS

[0033]

FIG. 1 is a diagram of a structure of an antenna according to an embodiment of this application;

FIG. 2 is a diagram of current distribution of an antenna according to an embodiment of this application at a first operating frequency with no conductive stub disposed in a case in which a first feed structure performs feeding and a second feed structure does not perform feeding;

FIG. 3 is a diagram of current distribution of an antenna according to an embodiment of this application at a first operating frequency with no conductive

stub disposed in a case in which a second feed structure performs feeding and a first feed structure does not perform feeding;

FIG. 4 is a diagram of current distribution of an antenna according to an embodiment of this application at a first operating frequency with a conductive stub disposed in a case in which a first feed structure performs feeding and a second feed structure does not perform feeding;

FIG. 5 is a diagram of current distribution of an antenna according to an embodiment of this application at a first operating frequency with a conductive stub disposed in a case in which a second feed structure performs feeding and a first feed structure does not perform feeding;

FIG. 6 is a diagram of current distribution of an antenna according to an embodiment of this application at a second operating frequency with no conductive stub disposed in a case in which a first feed structure performs feeding and a second feed structure does not perform feeding;

FIG. 7 is a diagram of current distribution of an antenna according to an embodiment of this application at a second operating frequency with a conductive stub disposed in a case in which a first feed structure performs feeding and a second feed structure does not perform feeding;

FIG. 8 is a diagram of current distribution of an antenna according to an embodiment of this application at a second operating frequency with no conductive stub disposed in a case in which a second feed structure performs feeding and a first feed structure does not perform feeding;

FIG. 9 is a diagram of current distribution of an antenna according to an embodiment of this application at a second operating frequency with a conductive stub disposed in a case in which a second feed structure performs feeding and a first feed structure does not perform feeding;

FIG. 10 is a diagram of current distribution of an antenna according to an embodiment of this application at a third operating frequency with no conductive stub disposed in a case in which a first feed structure performs feeding and a second feed structure does not perform feeding;

FIG. 11 is a diagram of current distribution of an antenna according to an embodiment of this application at a third operating frequency with a conductive stub disposed in a case in which a first feed structure performs feeding and a second feed structure does not perform feeding;

FIG. 12 is a diagram of current distribution of an antenna according to an embodiment of this application at a third operating frequency with no conductive stub disposed in a case in which a second feed structure performs feeding and a first feed structure does not perform feeding;

FIG. 13 is a diagram of current distribution of an

antenna according to an embodiment of this application at a third operating frequency with a conductive stub disposed in a case in which a second feed structure performs feeding and a first feed structure does not perform feeding;

FIG. 14 is a diagram of comparison between an isolation curve of the antenna shown in FIG. 1 with a conductive stub and an isolation curve of the antenna shown in FIG. 1 without the conductive stub; FIG. 15 is a diagram of a relationship between a width change of a slit and an offset of a dent of an isolation curve;

FIG. 16 is a diagram of a relationship between a length change of a conductive stub and an offset of a dent of an isolation curve;

FIG. 17 is a diagram of a structure of an antenna according to another embodiment of this application; FIG. 18 is a diagram of comparison between an isolation curve of the antenna shown in FIG. 17 with a conductive stub and an isolation curve of the antenna shown in FIG. 17 without the conductive stub;

FIG. 19 is a diagram of a structure of an antenna according to still another embodiment of this application; and

FIG. 20 is a diagram of comparison between an isolation curve of the antenna shown in FIG. 19 with a conductive stub and an isolation curve of the antenna shown in FIG. 19 without the conductive stub.

Reference numerals:

[0034]

1: dielectric substrate;

11: first antenna;

111: first half-open groove;

111a: first side wall;

111b: second side wall;

12: second antenna;

121: second half-open groove;

121a: first side wall;

121b: second side wall;

13: conductive stub;

131: first segment;

132: second segment;

14: slit;

2: conductor component;

21: ground plane;

22: ground part;

3: first feed structure;

31a: first coupling piece;

31b: first feed point;

32a: first feeder;

32b: first feed point;

4: second feed structure;

41a: second coupling piece;

41b: second feed point;

42a: second feeder;

42b: second feed point; and

H: physical distance.

[0035] The accompanying drawings herein are incorporated into this specification and constitute a part of this specification, to show embodiments in accordance with this application, and are used, together with this specification, to explain the principle of this application.

DESCRIPTION OF EMBODIMENTS

[0036] To better understand technical solutions of this application, the following describes embodiments of this application in detail with reference to the accompanying drawings. It should be understood that the specific embodiments described herein are merely used to explain this application but are not intended to limit this application.

[0037] In the descriptions of this application, unless otherwise explicitly specified or defined, the terms "first" and "second" are merely used for a purpose of description, and shall not be understood as an indication or implication of relative importance. Unless otherwise specified or explained, the term "a plurality of" refers to two or more. The terms "connection", "fastened", and the like should be understood in a broad sense. For example, the "connection" may be a fastened connection, or may be a detachable connection, an integrated connection, or an electrical connection; or the "connection" may be a direct connection, or an indirect connection through an intermediary. A person of ordinary skill in the art may understand specific meanings of the foregoing terms in this application based on specific situations.

[0038] Customer premises equipment (customer premises equipment, CPE) is a device that converts an LTE signal or an NR signal received from a base station into a Wi-Fi signal and then sends the Wi-Fi signal for access of a user terminal. The customer premises equipment may be specifically a card wireless router, a mobile portable router, or the like, and receives and sends a radio signal through an antenna disposed inside.

[0039] However, with wide application of a MIMO tech-

nology, a quantity of antennas in the customer premises equipment increases. Because space in the customer premises equipment is limited, an increase in the quantity of antennas inevitably leads to a decrease in an isolation between antennas, and consequently, antenna performance is reduced.

[0040] To improve the isolation between the antennas, an additional decoupling structure is usually considered to be added between two antennas in the conventional technology, for example, a neutralization line, a resonant stub, or a resonant slit is added between the two antennas. However, adding the additional decoupling measure causes a more complex antenna structure, and a large distance needs to be maintained between two adjacent antennas to provide space for arrangement of the decoupling structure. Consequently, the antenna occupies more device space. This is not conducive to device miniaturization.

[0041] Embodiments of this application provide an antenna and a terminal device. The terminal device may be customer premises equipment, for example, a card wireless router or a mobile portable router. The antenna may be used in the terminal device.

[0042] FIG. 1 is a diagram of a structure of an antenna according to an embodiment of this application. As shown in FIG. 1, the antenna specifically includes a dielectric substrate 1, a conductor component 2, a first feed structure 3, and a second feed structure 4. The conductor component 2 may be a thin-plate structure made of a conductive material, for example, a metal plate. In this embodiment, the conductor component 2 is an integrated plate part. The conductor component 2 is at least partially disposed on the dielectric substrate 1. The dielectric substrate 1 may be a dielectric plate of a flame-resistant material (FR-4), or a Rogers (Rogers) dielectric plate, or a hybrid dielectric plate of Rogers and FR-4, or the like. FR-4 is a grade code name of a flame-resistant material, and the Rogers dielectric plate is a high-frequency plate.

[0043] The conductor component 2 is provided with a first half-open groove 111 and a second half-open groove 121 that do not connect to each other, and an opening direction of the first half-open groove 111 and an opening direction of the second half-open groove 121 are away from each other. In an embodiment, the first half-open groove 111 and the second half-open groove 121 each are a half-open groove formed on the conductor component 2 through material removal, direct molding, or the like, and the first half-open groove 111 and the second half-open groove 121 do not connect to each other, so that a structure at the first half-open groove 111 and a structure at the second half-open groove 121 each may form one antenna. The formed antenna may be a slot antenna, a left-hand antenna, an inverted F antenna (IFA, Inverted F Antenna), or the like. In an embodiment, the first half-open groove 111 and the second half-open groove 121 may be formed by combining a plurality of conductive parts. For example, the terminal device may include a conductive frame, and the conductive frame

may be formed as a side wall of the first half-open groove 111 and the second half-open groove 121. The conductive frame, as the side wall of the first half-open groove 111 and the second half-open groove 121, is not in contact with the dielectric substrate, and only a ground part of the conductor component 2 is in contact with the dielectric substrate, so that the conductive frame and the ground part form the conductor component 2 through combination. In addition, a conductive stub 13 may also be connected to the dielectric substrate and the conductor component 2 through a spring plate, so that the conductive stub 13 and the conductor component 2 can also be connected through combination. Certainly, the conductive stub 13 and the conductor component 2 may be of an integrated structure.

[0044] In this embodiment, as shown in FIG. 1, for ease of description, the antenna formed at the first half-open groove 111 is defined as a first antenna 11, and the antenna formed at the second half-open groove 121 is defined as a second antenna 12. The first feed structure 3 is disposed in the first half-open groove 111, the second feed structure 4 is disposed in the second half-open groove 121, and both the first feed structure 3 and the second feed structure 4 may feed the two antennas. The conductive stub 13 is further disposed on a side that is of the conductor component 2 and that is in the opening direction of the second half-open groove 121. The conductive stub 13 may be specifically a resonant stub. The resonant stub may excite conductor component a specific resonance frequency such as 2.3 GHz, 3.2 GHz, or 4.5 GHz in cooperation with the conductor component 2, the first feed structure 3, and the second feed structure 4. A first end of the conductive stub 13 is connected to a first side wall 121a of the second half-open groove 121, and a slit 14 is disposed between a second end of the conductive stub 13 and a second side wall 121b of the second half-open groove 121.

[0045] The first half-open groove 111 has two side walls perpendicular to the opening direction of the first half-open groove 111, and the second half-open groove 121 also has two side walls perpendicular to the opening direction of the second half-open groove 121. For ease of description, in this embodiment, the two side walls that are of the first half-open groove 111 and that are perpendicular to the opening direction of the first half-open groove 111 are respectively defined as a first side wall 111a and a second side wall 111b of the first half-open groove 111, and the two side walls that are of the second half-open groove 121 and that are perpendicular to the opening direction of the second half-open groove 121 are respectively defined as the first side wall 121a and the second side wall 121b of the second half-open groove 121.

[0046] FIG. 2 is a diagram of current distribution of the antenna according to this embodiment of this application at a first operating frequency without the conductive stub 13 disposed in a case in which the first feed structure 3 performs feeding and the second feed structure 4 does

not perform feeding. As shown in FIG. 2, the first operating band includes 2.3 GHz. In a case in which the conductive stub 13 provided in this embodiment is not disposed, and the first antenna 11 and the second antenna 12 operate in a low frequency band, for example, 2 GHz to 2.5 GHz, when the first feed structure 3 performs feeding, and the second feed structure 4 does not perform feeding, current distribution of a current coupled to the second feed structure 4 through the first side wall 121a and the second side wall 121b of the second half-open groove 121 is similar to current distribution during operation of the second antenna 12. Therefore, an isolation between the two antennas is poor. In an embodiment, operating frequencies of the antennas in FIG. 2 are around 2.3 GHz. FIG. 3 is a diagram of current distribution of the antenna according to this embodiment of this application at the first operating frequency without the conductive stub 13 disposed in a case in which the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding. As shown in FIG. 3, when the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding, current distribution of a current coupled to the feed structure 3 through the first side wall 111a and the second side wall 111b of the first half-open groove 111 is similar to current distribution during operation of the first antenna 11. Therefore, an isolation between the two antennas is poor. In an embodiment, operating frequencies of the antennas in FIG. 3 are around 2.3 GHz.

[0047] In this embodiment of this application, the conductive stub 13 is further disposed on the side that is of the conductor component 2 and that is in the opening direction of the second half-open groove 121, the first end of the conductive stub 13 is connected to the first side wall 121a of the second half-open groove 121, and the slit 14 is disposed between the second end of the conductive stub 13 and the second side wall 121b of the second half-open groove 121.

[0048] In an embodiment, a direction of a current that is on the conductive stub 13 and that is coupled to the first feed structure 3 through the first side wall 121a of the second half-open groove 121 is opposite to a direction of a current that is on the conductive stub 13 and that is coupled to the first feed structure 3 through the second side wall 121b of the second half-open groove 121. Specifically, FIG. 4 is a diagram of current distribution of the antenna according to this embodiment of this application at the first operating frequency with the conductive stub 13 disposed in a case in which the first feed structure 3 performs feeding and the second feed structure 4 does not perform feeding. As shown in FIG. 4, the conductive stub 13 may attract a current, so that when the first feed structure 3 performs feeding, a current directly coupled from the first side wall 121a of the second half-open groove 121 to the second feed structure 4 partially cancels a current coupled through the conductive stub 13. In this way, a difference between current distribution at the second feed structure 4 and current distribution

during operation of the second antenna 12 becomes larger, to implement decoupling.

[0049] FIG. 5 is a diagram of current distribution of the antenna according to this embodiment of this application at the first operating frequency with the conductive stub 13 disposed in a case in which the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding. As shown in FIG. 5, the conductive stub 13 may attract a current, so that a current coupled from the second feed structure 4 to the second side wall 121b of the second half-open groove 121 is further coupled to the conductive stub 13 through the slit 14, and the current in the conductive stub 13 may flow through the first side wall 121a of the second half-open groove 121 to the first side wall 111a of the first half-open groove 111. In addition, the current in the second side wall 121b of the second half-open groove 121 flows to the second side wall 111b of the first half-open groove 111, and is further coupled to the first side wall 111a of the first half-open groove 111. A direction of the current coupled to the first side wall 111a of the first half-open groove 111 is opposite to a direction of the current that is in the conductive stub 13 and that flows to the first side wall 111a of the first half-open groove 111. The currents in opposite directions cancel each other, to implement decoupling, so that the antenna has a high isolation.

[0050] For ease of description and understanding, FIG. 5 shows the currents before cancellation. It should be understood that, after the conductive stub 13 is disposed, a current flowing from the conductive stub 13 to the first feed structure 3 is generated, and the current and a current flowing from the first feed structure 3 to the second feed structure 4 cancel each other, so that directions of most of the currents are toward the first feed structure 3.

[0051] Therefore, when the antenna provided in this embodiment operates in a low frequency band like 2 GHz to 2.5 GHz, and any feed structure performs feeding, thanks to a specific structure, a specific connection, and a location relationship of the conductive stub 13, reverse currents cancel each other at the other feed structure, so that two antennas are decoupled. In this way, an isolation between the two antennas is improved.

[0052] It should be noted that, during actual operation, the first feed structure 3 and the second feed structure 4 may operate simultaneously, and current distribution during operation of each feed structure meets the foregoing corresponding cases.

[0053] In addition, the antenna includes a plurality of operating bands, for example, a low frequency band, an intermediate frequency band, and a high frequency band. The operating bands correspond to different wavelengths. For example, a wavelength of a low frequency band of 2 GHz to 2.5 GHz is long, and similar current distribution is formed at a location between the first antenna 11 and the second antenna 12, that is, currents are co-directionally distributed, and therefore, no cancellation effect is generated. Consequently, an isolation

between the first antenna 11 and the second antenna 12 is poor. However, if an existing additional decoupling structure is added, although an isolation of the antenna in a low frequency band can be improved to some extent, current distribution during operation of the antenna in an intermediate frequency band and a high frequency band is greatly changed. Consequently, isolations during operation of the antennas in the intermediate frequency band and the high frequency band become poor.

[0054] In this application, the antenna includes the conductive stub 13, and the conductive stub 13 adapts to a wavelength of a low frequency band of the antenna. Therefore, circuit distribution during operation of the antenna in the low frequency band can be improved by using the conductive stub 13, so that reverse currents cancel each other at the location between the first antenna 11 and the second antenna 12, thereby implementing low-frequency decoupling. In this way, an isolation during operation of the antennas in the low frequency band is improved. Because the conductive stub 13 adapts only to the wavelength of the low frequency band of the antenna, current distribution of the intermediate frequency band and the high frequency band is not affected. Wavelengths corresponding to the intermediate frequency band and the high frequency band are short, and distributed current can meet cycle distribution. Reverse currents cancel each other in an area between the first antenna 11 and the second antenna 12, so that the isolation between the antennas is good.

[0055] Therefore, in this application, an isolation during operation of the antenna in the low frequency band can be improved by using the conductive stub 13, and isolations during operation of the antenna in the intermediate frequency band and the high frequency band are not affected. In other words, the antennas can have a good isolation in each operating band.

[0056] Specifically, FIG. 6 is a diagram of current distribution of the antenna according to this embodiment of this application at a second operating frequency without the conductive stub 13 disposed in a case in which the first feed structure 3 performs feeding and the second feed structure 4 does not perform feeding. As shown in FIG. 6, the second working frequency includes 3.2 GHz. When the antenna without the conductive stub 13 operates at an intermediate frequency and a high frequency, for example, operates at a frequency of 3.2 GHz shown in FIG. 6, the first feed structure 3 performs feeding, and the second feed structure 4 does not perform feeding, there is no coupled current at the second feed structure 4. Therefore, there is a good isolation. In an embodiment, operating frequencies of the antennas in FIG. 6 are around 3.2 GHz.

[0057] FIG. 7 is a diagram of current distribution of the antenna according to this embodiment of this application at the second operating frequency with the conductive stub 13 disposed in a case in which the first feed structure 3 performs feeding and the second feed structure 4 does not perform feeding. As shown in FIG. 7, when the

antenna with the conductive stub 13 operates at an intermediate frequency and a high frequency, for example, operates at a frequency of 3.2 GHz shown in FIG. 7, the first feed structure 3 performs feeding, and the second feed structure 4 does not perform feeding, a current in the conductive stub 13 is not coupled to the second feed structure 4, and there is no coupled current at the second feed structure 4. Therefore, there is still a good isolation.

[0058] FIG. 8 is a diagram of current distribution of the antenna according to this embodiment of this application at the second operating frequency without the conductive stub 13 disposed in a case in which the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding. As shown in FIG. 8, when the antenna without the conductive stub 13 operates at an intermediate frequency and a high frequency, for example, operates at a frequency of 3.2 GHz shown in FIG. 8, the second feed structure 4 performs feeding, and the first feed structure 3 does not perform feeding, there is no coupled current at the first feed structure 3. Therefore, there is a good isolation.

[0059] FIG. 9 is a diagram of current distribution of the antenna according to this embodiment of this application at the second operating frequency with the conductive stub 13 disposed in a case in which the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding. As shown in FIG. 9, when the antenna with the conductive stub 13 operates at an intermediate frequency and a high frequency, for example, operates at a frequency of 3.2 GHz shown in FIG. 9, the second feed structure 4 performs feeding, and the first feed structure 3 does not perform feeding, the current in the conductive stub 13 is not coupled to the first feed structure 3, and there is no coupled current at the first feed structure 3. Therefore, there is still a good isolation.

[0060] FIG. 10 is a diagram of current distribution of the antenna according to this embodiment of this application at a third operating frequency without the conductive stub 13 disposed in a case in which the first feed structure 3 performs feeding and the second feed structure 4 does not perform feeding. As shown in FIG. 10, the third working frequency includes 4.5 GHz. When the antenna without the conductive stub 13 operates at a high frequency, for example, operates at a frequency of 4.5 GHz shown in FIG. 10, the first feed structure 3 performs feeding, and the second feed structure 4 does not perform feeding, there is no coupled current at the second feed structure 4.

[0061] Therefore, there is a good isolation. In an embodiment, operating frequencies of the antennas in FIG. 10 are around 4.5 GHz.

[0062] FIG. 11 is a diagram of current distribution of the antenna according to this embodiment of this application at the third operating frequency with the conductive stub 13 disposed in a case in which the first feed structure 3 performs feeding and the second feed structure 4 does not perform feeding. As shown in FIG. 11, when the antenna with the conductive stub 13 operates at a high

frequency, for example, operates at a frequency of 4.5 GHz shown in FIG. 11, the first feed structure 3 performs feeding, and the second feed structure 4 does not perform feeding, the current in the conductive stub 13 is not coupled to the second feed structure 4, and there is no coupled current at the second feed structure 4. Therefore, there is still a good isolation.

[0063] FIG. 12 is a diagram of current distribution of the antenna according to this embodiment of this application at the third operating frequency without the conductive stub 13 disposed in a case in which the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding. As shown in FIG. 12, when the antenna without the conductive stub 13 operates at a high frequency, for example, operates at a frequency of 4.5 GHz shown in FIG. 12, the second feed structure 4 performs feeding, and the first feed structure 3 does not perform feeding, there is no coupled current at the first feed structure 3. Therefore, there is a good isolation.

[0064] FIG. 13 is a diagram of current distribution of the antenna according to this embodiment of this application at the third operating frequency with the conductive stub 13 disposed in a case in which the second feed structure 4 performs feeding and the first feed structure 3 does not perform feeding. As shown in FIG. 13, when the antenna with the conductive stub 13 operates at a high frequency, for example, operates at a frequency of 4.5 GHz shown in FIG. 13, the second feed structure 4 performs feeding, and the first feed structure 3 does not perform feeding, the current in the conductive stub 13 is not coupled to the first feed structure 3, and there is no coupled current at the first feed structure 3. Therefore, there is still a good isolation.

[0065] In other words, the antenna with the conductive stub 13 provided in embodiments of this application can achieve a good isolation between antennas and a large decoupling bandwidth while covering low, intermediate, and high frequency bands of 2 GHz to 5 GHz. In addition, the antenna provided in embodiments of this application is two antennas formed on one conductor component 2. The conductive stub 13 is disposed on one side of one of the antennas to improve the isolation of the antennas. In addition, the slit 14 is disposed between the conductive stub 13 and only one antenna, and does not need to be disposed between two independent antennas and maintain a distance between both of the two antennas, as in a conventional decoupling structure. Therefore, the antenna provided in embodiments of this application can implement antenna size miniaturization, thereby reducing occupied space. This facilitates miniaturization of customer premises equipment and deployment of more antennas in limited space.

[0066] FIG. 14 is a diagram of comparison between an isolation curve of the antenna shown in FIG. 1 with the conductive stub 13 and an isolation curve of the antenna shown in FIG. 1 without the conductive stub 13. A dashed line represents the isolation curve of the antenna without the conductive stub 13, and a solid line represents the

isolation curve of the antenna with the conductive stub 13. As shown in FIG. 14, when the antenna operates in a frequency band of 2 GHz to 5 GHz, an isolation of the antenna without the conductive stub 13 in a low frequency band of 2 GHz to 2.5 GHz is poor. For example, at a frequency of 2.3 GHz, an isolation of the antenna without the conductive stub 13 is -11.632 dB, and an isolation of the antenna with the conductive stub 13 is -26.077 dB, that is, the isolation of the antenna with the conductive stub 13 is relatively improved by about 15 dB. In addition, as shown in FIG. 14, the isolation curve of the antenna with the conductive stub 13 has three isolation dents in the low frequency band of 2 GHz to 2.5 GHz. Improvement of the isolation is wideband, and an isolation in an entire band is good, which is above -15 dB.

[0067] Specifically, a width of the slit 14 may be greater than or equal to 1 mm, so that the conductive stub 13 can improve an isolation during operation of the antenna in the low frequency band of 2 GHz to 2.5 GHz. In this embodiment, the width of the slit 14 is preferably 1 mm to 4 mm, and in this width range, the isolation in the frequency band of 2 GHz to 2.5 GHz can be effectively improved.

[0068] It should be noted that FIG. 15 is a diagram of a relationship between a width change of the slit 14 and an offset of a dent of an isolation curve. As shown in FIG. 15, as the width of the slit 14 is further increased, a frequency corresponding to an optimal isolation value tends to offset toward a high frequency. FIG. 15 shows three isolation curves: a curve a1, a curve a2, and a curve a3. The curve a1 corresponds to a slit 14 with a minimum width D. The curve a1 forms a dent at a frequency of 2.34 GHz, and an isolation corresponding to the dent is -26.076 dB. A width of a slit 14 corresponding to the curve a2 is increased by 2 mm (D+2 mm shown in FIG. 15) relative to the width of the slit corresponding to the curve a1, so that the curve a2 forms a dent at a frequency of 2.45 GHz, and an isolation corresponding to the dent is -26.84 dB. A width of a slit 14 corresponding to the curve a3 is increased by 4 mm (D+4 mm shown in FIG. 15) relative to the width of the slit corresponding to the curve a1, so that the curve a3 forms a dent at a frequency of 2.5 GHz, and an isolation corresponding to the dent is -26.008 dB. It can be learned that, as the width of the slit 14 is increased, the dent of the isolation curve (the frequency corresponding to the optimal isolation value) offsets toward the high frequency.

[0069] In addition, FIG. 16 is a diagram of a relationship between a length change of the conductive stub 13 and an offset of a dent of the isolation curve. As shown in FIG. 16, as a physical length of the conductive stub 13 is further reduced, the frequency corresponding to the optimal isolation value also tends to offset toward the high frequency. FIG. 16 shows three isolation curves: a curve b1, a curve b2, and a curve b3. The curve b1 corresponds to a conductive stub 13 with a maximum length L. The curve b1 forms a dent at a frequency of 2.34 GHz, and an isolation corresponding to the dent is -26.076 dB. A length of a conductive stub 13 corresponding to the curve

b2 is decreased by 2 mm (L-2 mm shown in FIG. 16) relative to the length of the conductive stub 13 corresponding to the curve b1, so that the curve b2 forms a dent at a frequency of 2.4 GHz, and an isolation corresponding to the dent is -40.325 dB. A length of a conductive stub 13 corresponding to the curve b3 is decreased by 4 mm (L-4 mm shown in FIG. 16) relative to the length of the conductive stub 13 corresponding to the curve b1, so that the curve b3 forms a dent at a frequency of 2.5 GHz, and an isolation corresponding to the dent is -30.347 dB. It can be learned that, as the length of the conductive stub 13 is decreased, the dent of the isolation curve (the frequency corresponding to the optimal isolation value) offsets toward the high frequency.

[0070] Therefore, the width of the slit 14 and the length of the conductive stub 13 may be adjusted in a coordinated manner, to adjust an isolation of the antenna during operation of the antenna in a specified frequency band. For example, when an isolation in the frequency band of 2 GHz to 2.5 GHz needs to be improved, and the width of the slit 14 needs to be designed to be large, the length of the conductive stub 13 may be correspondingly decreased based on different antenna structure requirements, so that a frequency with an optimal isolation is within the frequency band of 2 GHz to 2.5 GHz; and for another example, when the width of the slit 14 needs to be designed to be small, the length of the conductive stub 13 may be correspondingly increased, so that the frequency with the optimal isolation is within the frequency band of 2 GHz to 2.5 GHz.

[0071] Specifically, as shown in FIG. 1, the conductor component 2 is provided with a ground part 22 and a ground plane 21, and the first half-open groove 111 and the second half-open groove 121 are separated by using the ground part 22 and are connected to the ground plane 21. The ground plane 21 and the ground part 22 each are a part of the conductor component 2. The ground part 22 is a common part of the first half-open groove 111 and the second half-open groove 121, and the first half-open groove 111 and the second half-open groove 121 are grounded by using the ground part 22. Further, a part of the ground plane 21 may serve as the first side wall 111a of the first half-open groove 111 and the first side wall 121a of the second half-open groove 121. That is, the first half-open groove 111 and the second half-open groove 121 are formed on one conductor component 2, so that the first antenna 11 formed at the first half-open groove 111 and the second antenna 12 formed at the second half-open groove 121 may form an antenna. This helps reduce an overall size of the antenna, thereby reducing occupied space.

[0072] Specifically, in an existing manner of implementing decoupling by adding a neutralizing wire or a resonant component between antennas, a thickness of the neutralizing wire or the resonant component usually needs to be greater than 10 mm to implement decoupling. When decoupling is implemented only in a manner of a spacing in space without adding a neutralizing wire or a

resonant component between antennas, the spacing in the space usually needs to be greater than 60 mm. Therefore, no matter which of the existing decoupling manners is used, the antenna has a large size and occupies large space. In an embodiment, both the first half-open groove 111 and the second half-open groove 121 extend in a first direction, the first direction is a length direction of the first half-open groove 111 and the second half-open groove 121, and a width of the ground part in the first direction is less than or equal to 6 mm. In an embodiment, the first half-open groove 111 and the second half-open groove 121 each has a part extending in a first direction, for example, a first part that extends in the first direction and that is of the first half-open groove 111 and a second part that extends in the first direction and that is of the second half-open groove 121, where the first part and the second part are separated by using the ground part, and a width of the ground part in the first direction is less than or equal to 6 mm. In an embodiment, the width of the ground part may be less than or equal to 4 mm, or less than or equal to 3 mm. The ground part 22 is interposed between the first half-open groove 111 and the second half-open groove 121, and the width of the ground part 22 in the first direction is within a preset range, to implement antenna miniaturization, thereby reducing occupied space.

[0073] In a specific implementation, as shown in FIG. 1, an electrical length between an end part of the second side wall 121b of the second half-open groove 121 and a center of the ground part 22 is a quarter wavelength of a target frequency band of the antenna, thereby helping improve an energy traction effect of the conductive stub 13. The target frequency band of the antenna may be a central operating band whose isolation is to be improved.

[0074] The electrical length may be expressed by multiplying a physical length (namely, a mechanical length or a geometric length) by a ratio of a transmission time period of an electrical or electromagnetic signal in a medium to a time period required by this signal to travel, in free space, for a distance that is the same as the physical length of the medium. The electrical length may satisfy the following formula:

$$\overline{L} = L \times \frac{a}{b}$$

[0075] Herein, L is the physical length, and a is the transmission time period of the electrical or electromagnetic signal in the medium, and b is the transmission time period in the free space. Alternatively, the electrical length may be a ratio of a physical length (namely, a mechanical length or a geometric length) to a wavelength of a transmitted electromagnetic wave. The electrical length may satisfy the following formula:

$$\overline{L} = \frac{L}{\lambda}$$

[0076] Herein, L is the physical length, and λ is the wavelength of the electromagnetic wave.

[0077] That is, a physical distance H between the end part of the second side wall 121b of the second half-open groove 121 and the center of the ground part 22 may be calculated based on the electrical length between the end part of the second side wall 121b of the second half-open groove 121 and the center of the ground part 22 according to the foregoing formula. As shown in FIG. 1, the physical distance may alternatively be equivalent to a physical length of the second side wall 121b of the second half-open groove 121.

[0078] In a specific implementation, as shown in FIG. 1, the conductive stub 13 is a straight-line extension structure. Specifically, an extension direction of the conductive stub 13 is perpendicular to the opening direction of the second half-open groove 121, and an electrical length of the conductive stub 13 in the extension direction is less than or equal to the quarter wavelength of the target frequency band of the antenna. As shown in FIG. 1, in this embodiment, the opening direction of the second half-open groove 121 is defined as an X direction, the extension direction of the conductive stub 13 is defined as a Y direction, and the X direction is perpendicular to the Y direction. It should be noted that, in this embodiment, a perpendicular relationship between the X direction and the Y direction is not strictly perpendicular in a mathematical sense, but a deviation range is allowed. In other words, an angle between the extension direction of the conductive stub 13 and the opening direction of the second half-open groove 121 is not strictly 90° , and may be an angle close to 90° , for example, 88° , 89° , 90° , 100° , or 101° . The electrical length of the conductive stub 13 in the extension direction Y is less than or equal to the quarter wavelength of the target frequency band of the antenna, so that an energy traction effect of the conductive stub 13 can be improved. The electrical length of the conductive stub 13 is an electrical length corresponding to a distance between the first end and the second end of the conductive stub 13.

[0079] As shown in FIG. 1, an upper end face of the conductive stub 13 is flush with an upper surface of the second side wall 121b of the second half-open groove 121. The upper end face of the conductive stub 13 is an end face of a side that is of the conductive stub 13 in the extension direction Y of the conductive stub 13 and that is away from the ground plane 21. The upper surface of the second side wall 121b of the second half-open groove 121 is a surface of a side that is of the second side wall 121b of the second half-open groove 121 and that is away from the ground plane 21. The upper end surface of the conductive stub 13 is flush with the upper surface of the second side wall 121b of the second half-open groove 121, so that an optimal energy traction effect of the conductive stub 13 can be achieved.

[0080] In another specific implementation, FIG. 19 is a diagram of a structure of an antenna according to another embodiment of this application. As shown in FIG. 19, the

conductive stub 13 may alternatively be of a non-straight-line structure. In this embodiment, the conductive stub 13 includes a first segment 131 and a second segment 132, a first end of the first segment 131 is connected to the first side wall 121a of the second half-open groove 121, and a second end of the first segment 131 is connected to a first end of the second segment 132. Specifically, the first segment 131 and the second segment 132 may be integrally formed, and the slit 14 is disposed between a second end of the second segment 132 and the second side wall 121b of the second half-open groove 121. That is, in this embodiment, the conductive stub 13 may be in an L shape, so that a height of the conductive stub 13 above the ground plane 21 and a width of the slit 14 may be adjusted by adjusting a length of the first segment 131 and a length of the second segment 132. In this way, when the first antenna 11 and the second antenna 12 form different types of antennas, an optimal energy traction effect can be achieved.

[0081] A sum of an electrical length of the first segment 131 and an electrical length of the second segment 132 is less than or equal to the quarter wavelength of the target frequency band of the antenna, so that the non-straight-line conductive stub 13 can have a better energy traction effect. It may be understood that the physical length of the first segment 131 and the physical length of the second segment 132 may also be obtained through calculation based on the electrical length of the first segment 131 and the electrical length of the second segment 132 according to the foregoing formula. In some embodiments of this application, a sum of the physical length of the first segment 131 and the physical length of the second segment 132 may be understood as the sum of the electrical length of the first segment 131 and the electrical length of the second segment 132 $\pm 10\%$. In a specific implementation, as shown in FIG. 1 and FIG. 17, the first feed structure 3 includes a first coupling piece 31a, the first coupling piece 31a is disposed in the first half-open groove 111, and the first coupling piece 31a is provided with a first feed point 31b.

[0082] The conductor component 2 may be fed by using the first feed point 31b and the first coupling piece 31a, and a slot is formed between a surrounding edge of the first coupling piece 31a and a corresponding side wall of the first half-open groove 111, to form a coupling feed structure. In this way, a current can be evenly distributed on the ground plane 21, and a better bandwidth and omnidirectional radiation characteristic are provided.

[0083] Correspondingly, the second feed structure 4 may also include a second coupling piece 41a, the second coupling piece 41a is disposed in the second half-open groove 121, there is a slot between the second coupling piece 41a and an inner wall of the second half-open groove 121, and the second coupling piece 41a is provided with a second feed point 41b. A specific structure and an effect of the second feed structure 4 are the same as those of the first feed structure 3, and details are not described herein again.

[0084] When the first antenna 11 and/or the second antenna 12 form/form a slot antenna, the first coupling piece 31a and the second coupling piece 41a may feed energy into corresponding hollow slots of the first half-open groove 111 and the second half-open groove 121, to radiate an electromagnetic wave to the outside or receive an electromagnetic wave transmitted from the outside through the hollow slots. When the first antenna 11 and/or the second antenna 12 form/form a left-hand antenna, the first coupling piece 31a and the second coupling piece 41a may feed energy to corresponding side walls of the first half-open groove 111 and the second half-open groove 121, to radiate an electromagnetic wave to the outside or receive an electromagnetic wave transmitted from the outside through the side walls.

[0085] It should be noted that, it can be learned from the foregoing descriptions that the antenna formed by the first antenna 11 and the second antenna 12 may be a slot antenna or a left-hand antenna. As shown in FIG. 1, when a width of the first half-open groove 111 and a width of the second half-open groove 121 each are 2 mm to 10 mm, the first antenna 11 and the second antenna 12 mainly form the slot antenna. The first antenna 11 is used as an example. A hollow slot between the first side wall 111a and the second side wall 111b of the first antenna 11 is a main energy radiation area, and the hollow slot may be equivalent to a radiator of the first antenna 11.

[0086] The width of the first half-open groove 111 is a distance between the first side wall 111a and the second side wall 111b of the first half-open groove 111, and the width of the second half-open groove 121 is a distance between the first side wall 121a and the second side wall 121b of the second half-open groove 121.

[0087] FIG. 17 is a diagram of a structure of an antenna according to another embodiment of this application. As shown in FIG. 17, when a slot of the second half-open groove 121 is increased, specifically, may be greater than 10 mm, the distance between the first side wall 121a and the second side wall 121b of the second half-open groove 121 increases. As a result, a capacitance effect decreases, and field coupling decreases. In this case, slot radiation may be changed to trace radiation, that is, radiation is performed through the first side wall 121a and the second side wall 121b of the second half-open groove 121. In one embodiment, the second antenna 12 may form a left-handed antenna.

[0088] FIG. 18 is a diagram of comparison between an isolation curve of the antenna shown in FIG. 17 with the conductive stub 13 and an isolation curve of the antenna shown in FIG. 17 without the conductive stub 13. As shown in FIG. 18, an isolation of the antenna with the conductive stub 13 in a wide band of 1.8 GHz to 5 GHz is above -16 dB, and an isolation of the antenna without the conductive stub 13 in a wide band of 1.8 GHz to 2.5 GHz is below -15 dB. Therefore, the isolation of the antenna with the conductive stub 13 is better than that of the antenna without the conductive stub 13. At a frequency of 2 GHz, an isolation of the antenna with the conductive stub 13 is -

17.432 dB, and an isolation of the antenna without the conductive stub 13 is -10.681 dB. Therefore, the isolation of the antenna with the conductive stub 13 is increased by about 7 dB relative to the isolation of the antenna without the conductive stub 13, and improvement of the isolation is wideband, so that an isolation in an entire band is good.

[0089] In another specific implementation, FIG. 19 is a diagram of a structure of an antenna according to still another embodiment of this application. As shown in FIG. 19, the first feed structure 3 includes a first feed member 32a, the first feed member 32a is provided with a first feed point 32b, and a second end of the first feed member 32a is connected to the second side wall 111b of the first half-open groove 111.

[0090] The first feed member 32a is directly connected, for example, welded, to the second side wall 111b of the first half-open groove 111. Certainly, the first feed member 32a and the second side wall 111b of the first half-open groove 111 are of an integrated structure, that is, the first feed member 32a is also a part of the conductor component 2. A structure form in which the first feed member 32a directly bridges the two corresponding side walls of the first half-open groove 111 is used, so that the first antenna 11 forms an IFA antenna. In this embodiment, the second side wall 111b of the first half-open groove 111 may be directly fed by using the first feed member 32a, thereby facilitating simplification of an overall structure of the antenna.

[0091] Correspondingly, as shown in FIG. 19, the second feed structure 4 may further include a second feed member 42a, the second feed member 42a is provided with a second feed point 42b, and a second end of the second feed member 42a is connected to the second side wall 121b of the second half-open groove 121. The second feed member 42a and the first feed member 32a may have a same structure form and technical effect, and details are not described herein again. The first feed member 32a and the second feed member 42a each may be a feeder, or may be another mechanical part used for feeding. When both the first antenna 11 and the second antenna 12 are fed in a form of a feeder, both the first antenna 11 and the second antenna 12 form an IFA antenna.

[0092] FIG. 20 is a diagram of comparison between an isolation curve of the antenna shown in FIG. 19 with the conductive stub 13 and an isolation curve of the antenna shown in FIG. 19 without the conductive stub 13. A dashed line represents the isolation curve of the antenna without the conductive stub 13, and a solid line represents the isolation curve of the antenna with the conductive stub 13. As shown in FIG. 20, when the antenna operates in a frequency band of 2.3 GHz to 2.7 GHz, an in-band isolation of the antenna with the conductive stub 13 is above -17 dB, and a deepest point reaches -36.821 dB, while an in-band isolation of the antenna without the conductive stub 13 is below -13 dB, that is, the isolation is poor. At a frequency of 2.575 GHz, an isolation of the antenna without the conductive stub 13 is -12.169 dB,

and an isolation of the antenna with the conductive stub 13 is -36.821 dB. That is, the isolation of the antenna with the conductive stub 13 is increased by about 24 dB.

[0093] Certainly, one of the first half-open groove 111 and the second half-open groove 121 may alternatively use a structure of direct feeding by using a feeder, and the other may still use a structure of feeding by using a coupling piece, so that one of the first antenna 11 and the second antenna 12 may form an IFA antenna, and the other may form a slot antenna or a left-hand antenna. In this embodiment, the conductor component 2 may be fastened to a front side of the dielectric substrate 1, a feed circuit may be disposed on the front side of the dielectric substrate 1, and a back side of the dielectric substrate 1 is not coated with copper. The first feed point and the second feed point may be electrically connected to the feed circuit, so that the feed circuit, the first antenna 11, and the second antenna 12 may be disposed on a same side of the dielectric substrate 1, and there is no need to process the back side of the dielectric substrate 1, for example, by covering copper or disposing with a metal via or a waveguide. In this way, an overall volume of the antenna is reduced, and a structure is simplified.

[0094] The conductor component 2 may be completely fastened to the dielectric substrate 1, so that the antenna can be disposed inside the terminal device as a whole, for example, inside a housing of the terminal device, and the antenna may be covered by a side wall of the housing.

[0095] When the terminal device includes a metal frame, for example, the terminal device is a card wireless router having a metal frame or a movable portable router, or certainly may be a mobile phone, a tablet computer, a desktop computer, a laptop computer, a handheld computer, a notebook computer, or the like, the metal frame may be used as a part of the conductor component 2 to form an antenna. Specifically, the conductor component 2 includes the ground plane 21, and the ground plane 21 is disposed on the dielectric substrate 1. The first half-open groove 111 and the second half-open groove 121 are formed between the ground plane 21 and the metal frame, and the metal frame may form the second side wall 111b of the first half-open groove 111 and the second side wall 121b of the second half-open groove 121. That is, only a part that is of the conductor component 2 and that has the ground plane 21 may be disposed on the dielectric substrate 1, and the other part of the conductor component 2 may be formed by using the metal frame and further be combined to form the antenna.

[0096] The foregoing describes merely preferred embodiments of this application, and are not intended to limit this application. For a person skilled in the art, various modifications and changes may be made in this application. Any modification, equivalent replacement, or improvement made without departing from the spirit and principle of this application shall fall within the protection scope of this application.

Claims

1. An antenna, comprising:

a dielectric substrate;
a conductor component at least partially disposed on the dielectric substrate, wherein the conductor component is provided with a first half-open groove and a second half-open groove that do not connect to each other, and an opening direction of the first half-open groove and an opening direction of the second half-open groove are away from each other;
a conductive stub, disposed on a side that is of the conductor component and that is in the opening direction of the second half-open groove, wherein a first end of the conductive stub is connected to a first side wall of the second half-open groove, and a slit is disposed between a second end of the conductive stub and a second side wall of the second half-open groove;
a first feed structure, disposed in the first half-open groove; and
a second feed structure, disposed in the second half-open groove.

2. The antenna according to claim 1, wherein the conductor component comprises a ground part and a ground plane, the ground part is electrically connected to the ground plane, the first half-open groove and the second half-open groove are formed between the ground part and the ground plane, and the first half-open groove and the second half-open groove are separated by using the ground part.

3. The antenna according to claim 2, wherein the first half-open groove and the second half-open groove extend in a first direction, and a width of the ground part in the first direction is less than or equal to 6 mm.

4. The antenna according to claim 2 or 3, wherein an electrical length between an end part of the second side wall of the second half-open groove and a center of the ground part is a quarter wavelength of a target frequency band of the antenna.

5. The antenna according to any one of claims 1 to 4, wherein an extension direction of the conductive stub is perpendicular to the opening direction of the second half-open groove, and an electrical length of the conductive stub in the extension direction is less than or equal to the quarter wavelength of the target frequency band of the antenna.

6. The antenna according to any one of claims 1 to 5, wherein an upper end face of the conductive stub is flush with an upper surface of the second side wall of

the second half-open groove.

7. The antenna according to any one of claims 1 to 4, wherein the conductive stub comprises a first segment and a second segment, a first end of the first segment is connected to the first side wall of the second half-open groove, a second end of the first segment is connected to a first end of the second segment, and the slit is disposed between a second end of the second segment and the second side wall of the second half-open groove. 5
8. The antenna according to claim 7, wherein a sum of an electrical length of the first segment and an electrical length of the second segment is less than or equal to the quarter wavelength of the target frequency band of the antenna. 15
9. The antenna according to any one of claims 1 to 8, wherein the first feed structure comprises a first coupling piece, the first coupling piece is disposed in the first half-open groove, and the first coupling piece is provided with a first feed point. 20
10. The antenna according to any one of claims 1 to 8, wherein the first feed structure comprises a first feed member, a first end of the first feed member is provided with a first feed point, and a second end of the first feed member is connected to a second side wall of the first half-open groove. 25 30
11. The antenna according to claim 9 or 10, wherein the second feed structure comprises a second coupling piece, the second coupling piece is disposed in the second half-open groove, and the second coupling piece is provided with a second feed point. 35
12. The antenna according to claim 9 or 10, wherein the second feed structure comprises a second feed member, a first end of the second feed member is provided with a second feed point, and a second end of the second feed member is connected to the second side wall of the second half-open groove. 40
13. The antenna according to any one of claims 9 to 12, wherein the dielectric substrate is provided with a feed circuit, and both the first feed point and the second feed point are connected to the feed circuit. 45
14. The antenna according to claim 13, wherein the conductor component and the feed circuit are located on a same side of the dielectric substrate. 50
15. The antenna according to any one of claims 1 to 14, wherein a width of the slit is greater than or equal to 1 mm. 55
16. The antenna according to any one of claims 1 to 14,

wherein a width of the slit is 1 mm to 4 mm.

17. The antenna according to any one of claims 1 to 16, wherein the conductor component and the conductive stub are of an integrated structure.
18. A terminal device, comprising the antenna according to any one of claims 1 to 17.
19. The terminal device according to claim 18, wherein the terminal device comprises a metal frame, the conductor component comprises a ground plane, the ground plane is disposed on a dielectric substrate, a first half-open groove and a second half-open groove are formed between the ground plane and the metal frame, and the metal frame forms a second side wall of the first half-open groove and a second side wall of the second half-open groove.
20. The terminal device according to claim 18, wherein the terminal device comprises a housing, the antenna is disposed inside the housing, and a conductor component is completely disposed on a dielectric substrate.

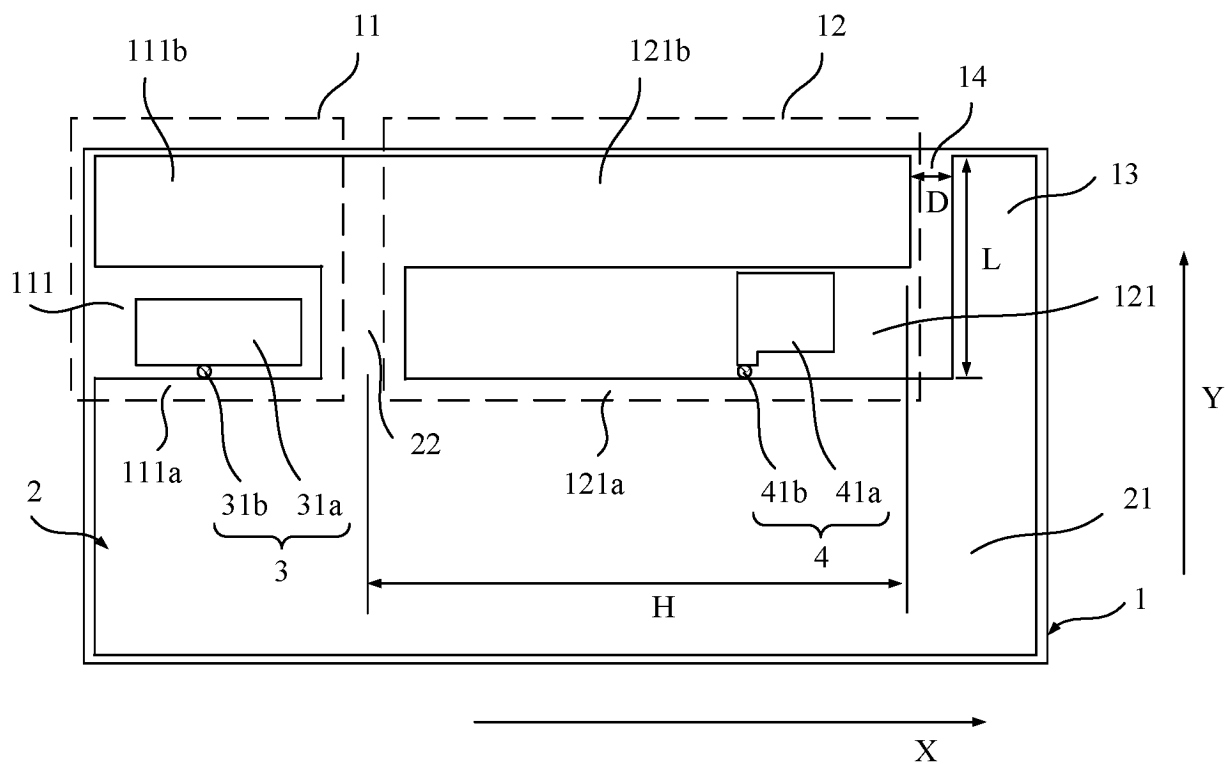


FIG. 1

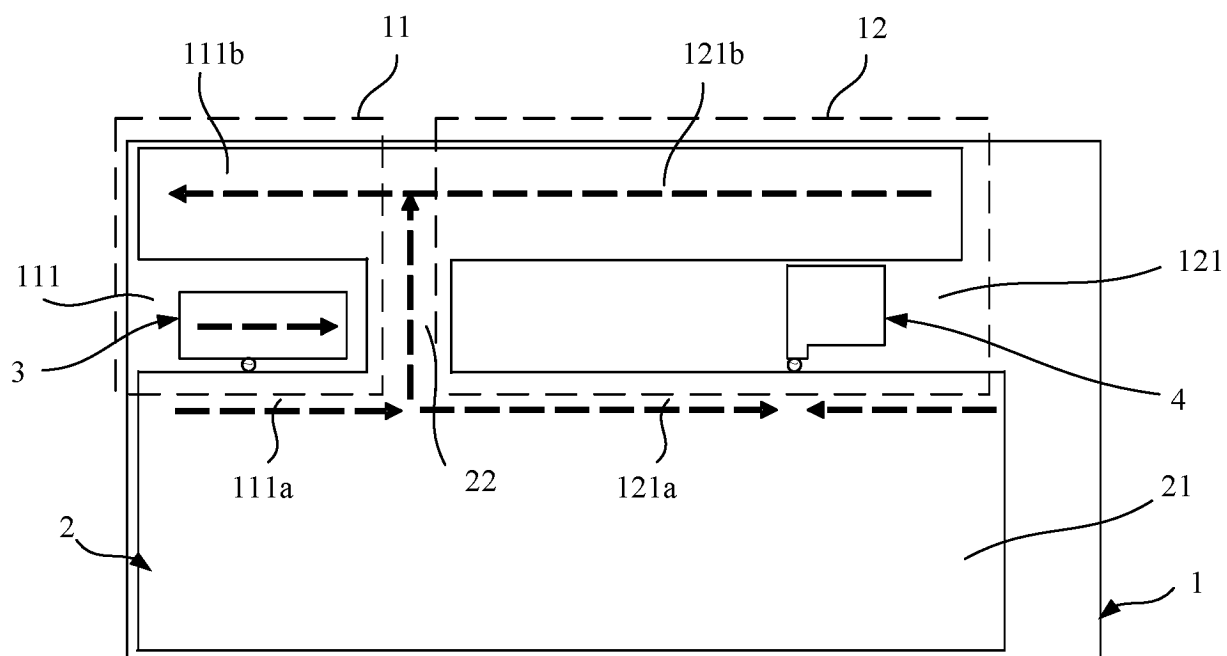


FIG. 2

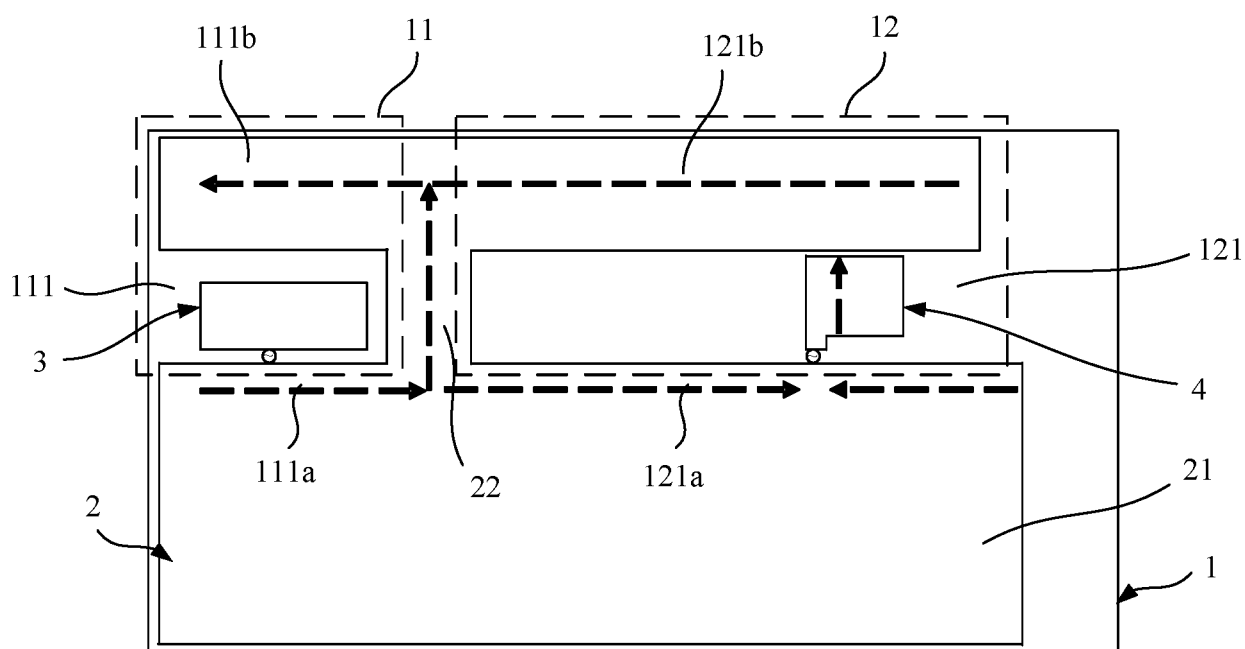


FIG. 3

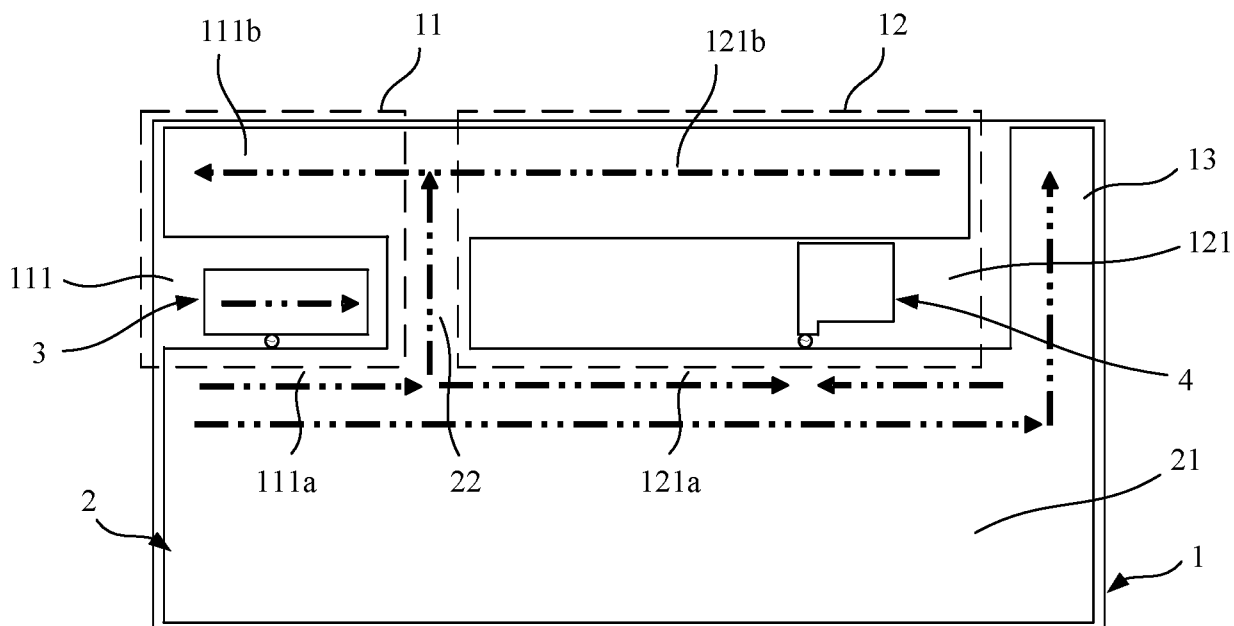


FIG. 4

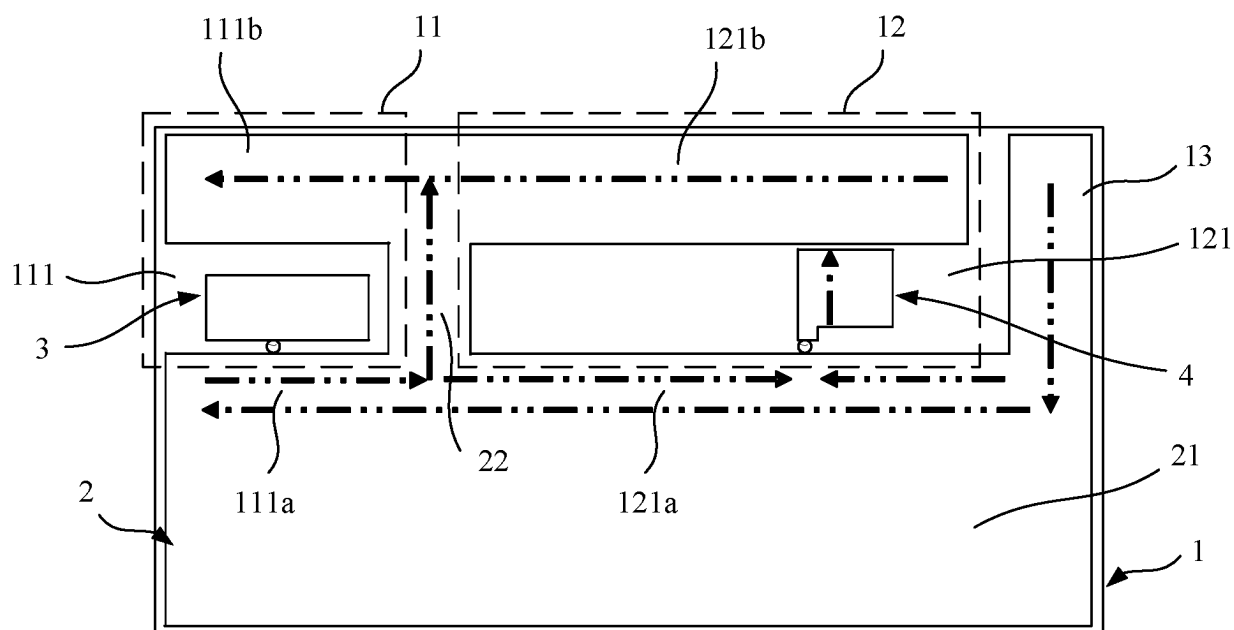


FIG. 5

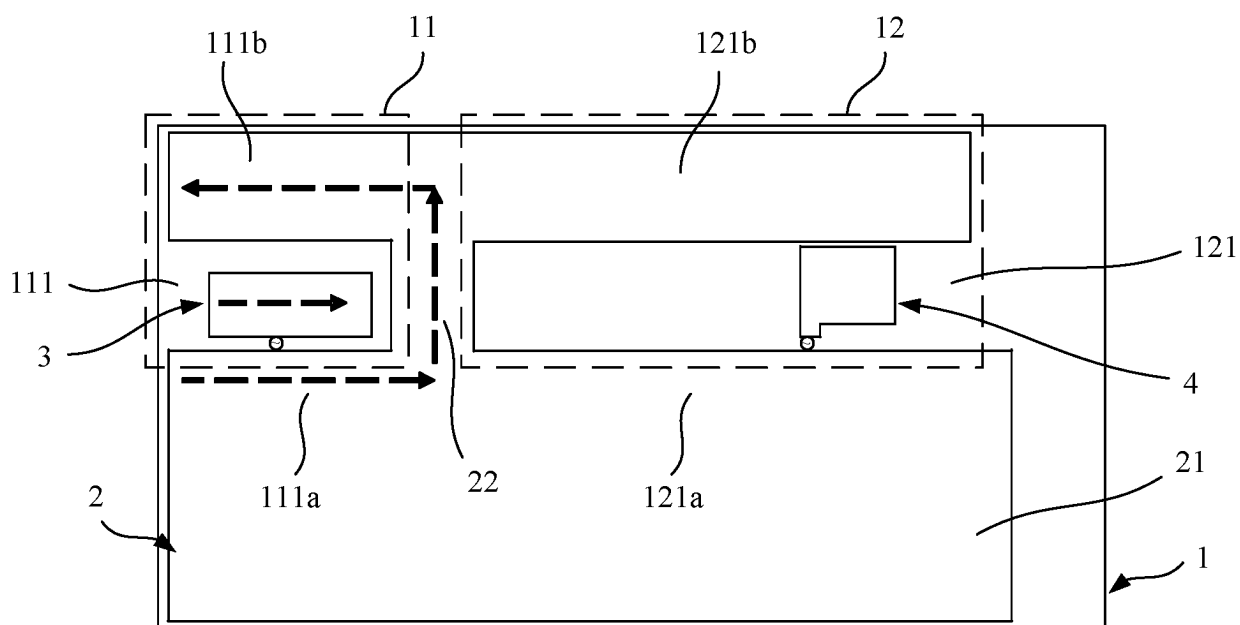


FIG. 6

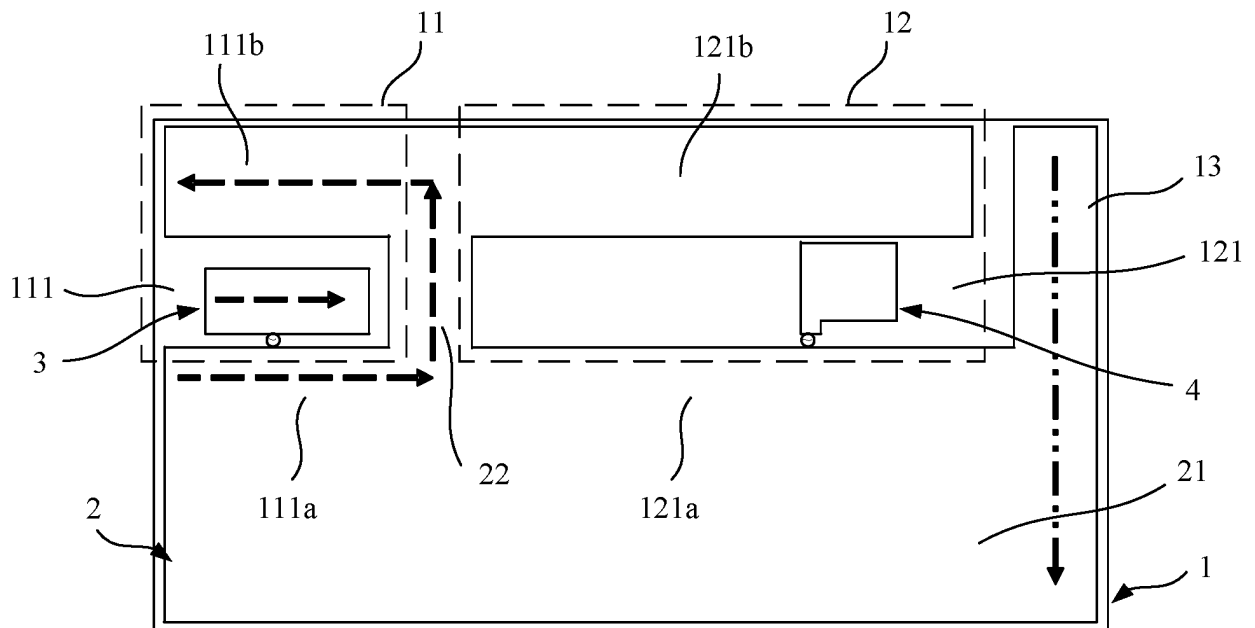


FIG. 7

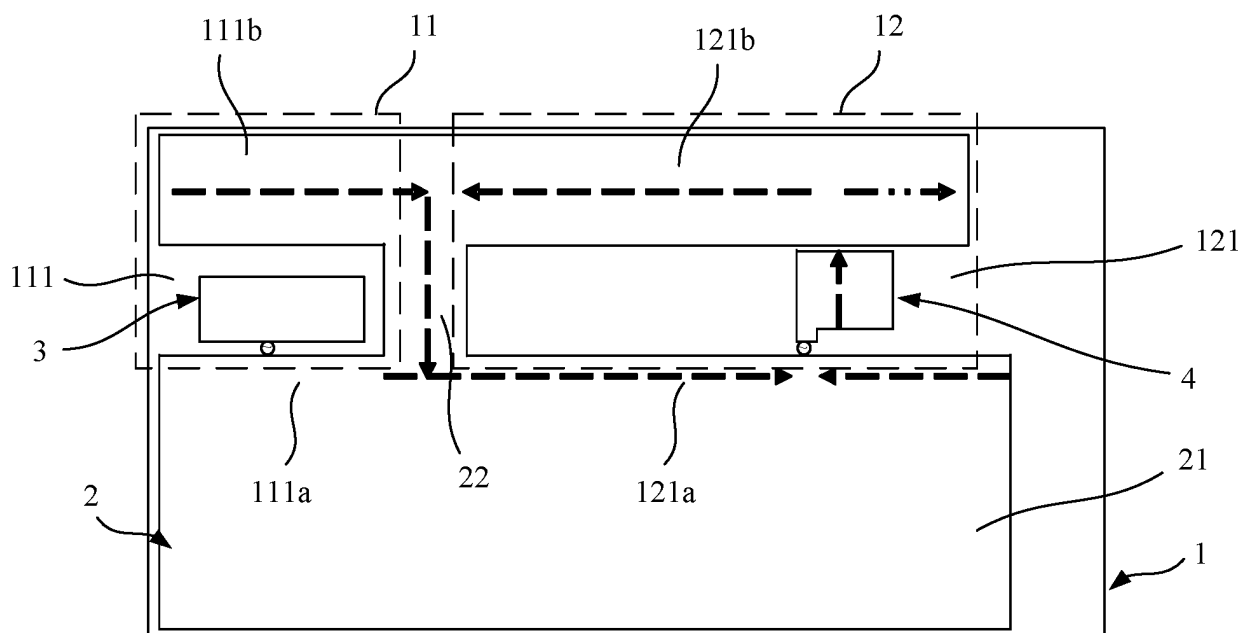


FIG. 8

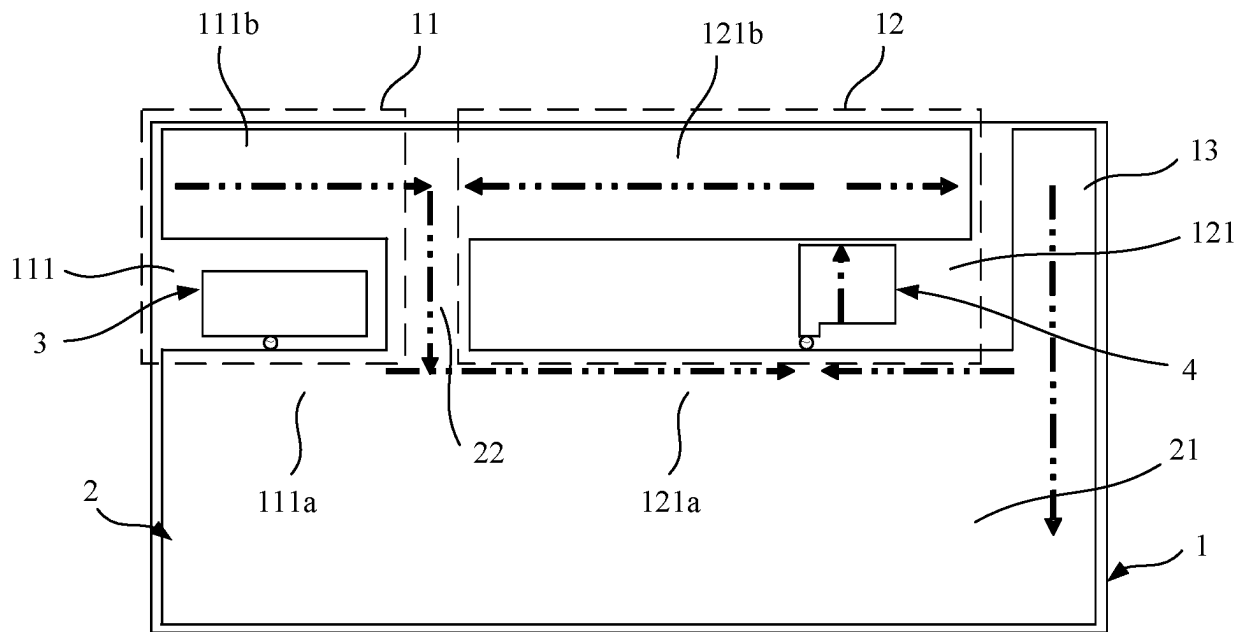


FIG. 9

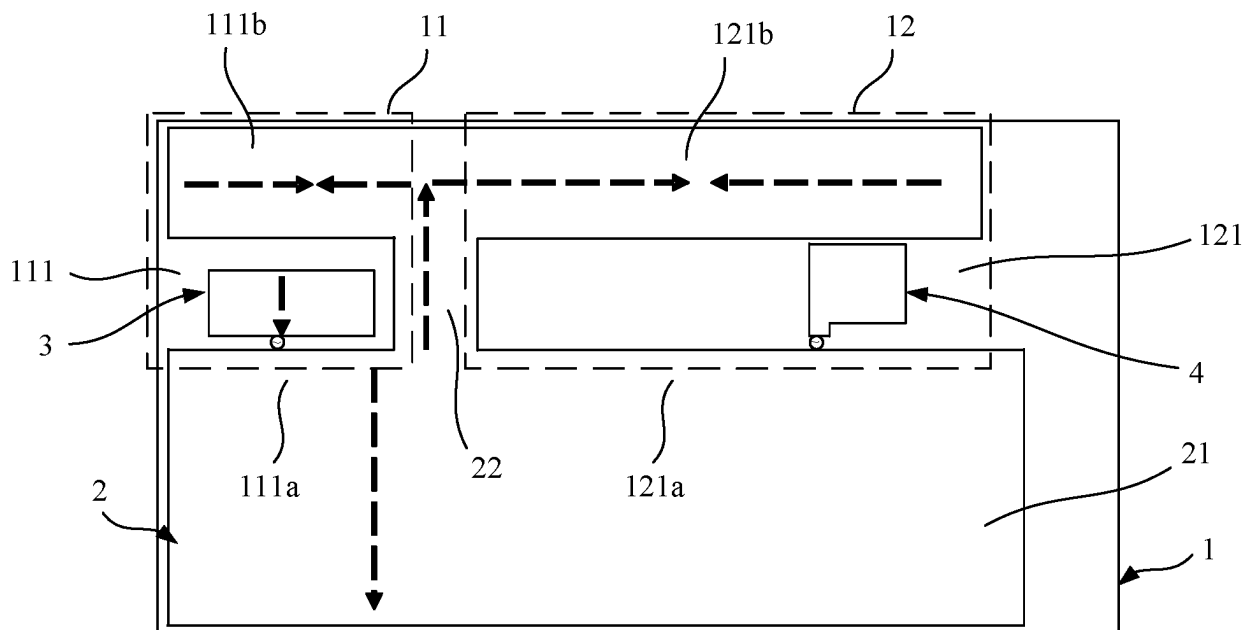


FIG. 10

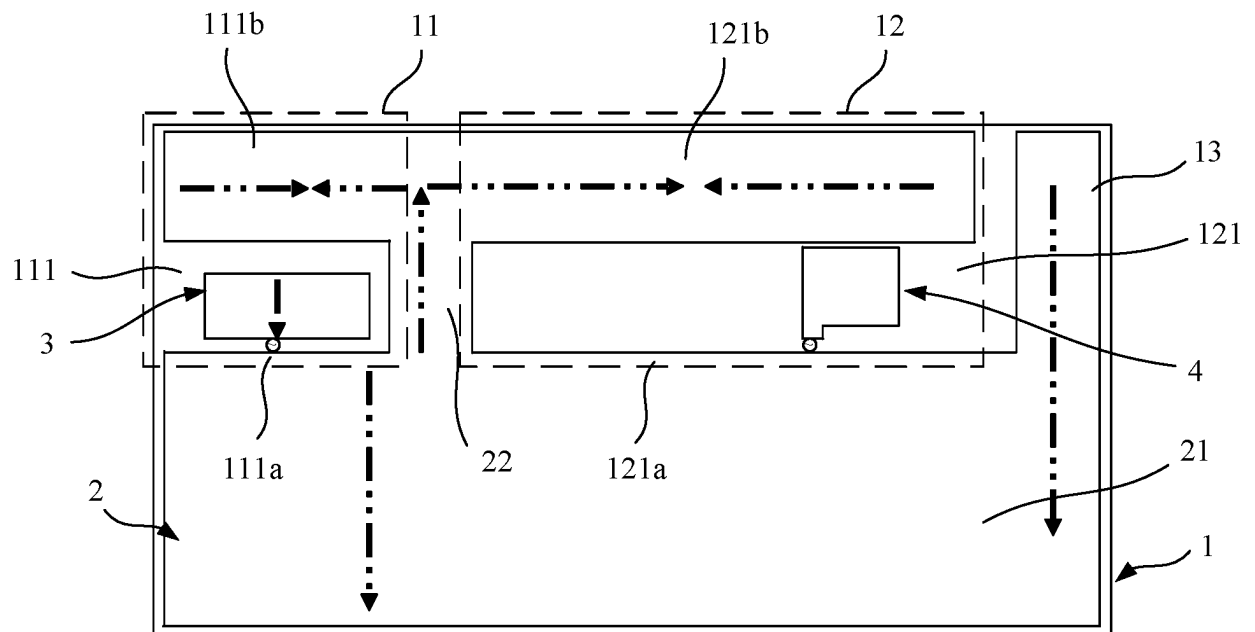


FIG. 11

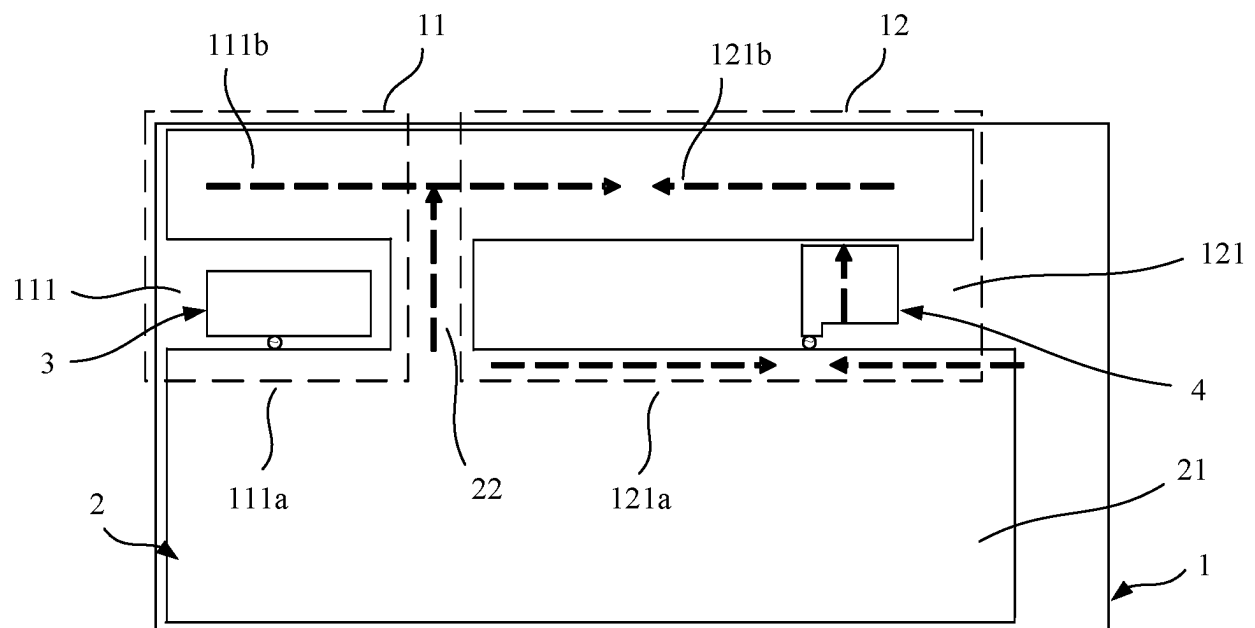


FIG. 12

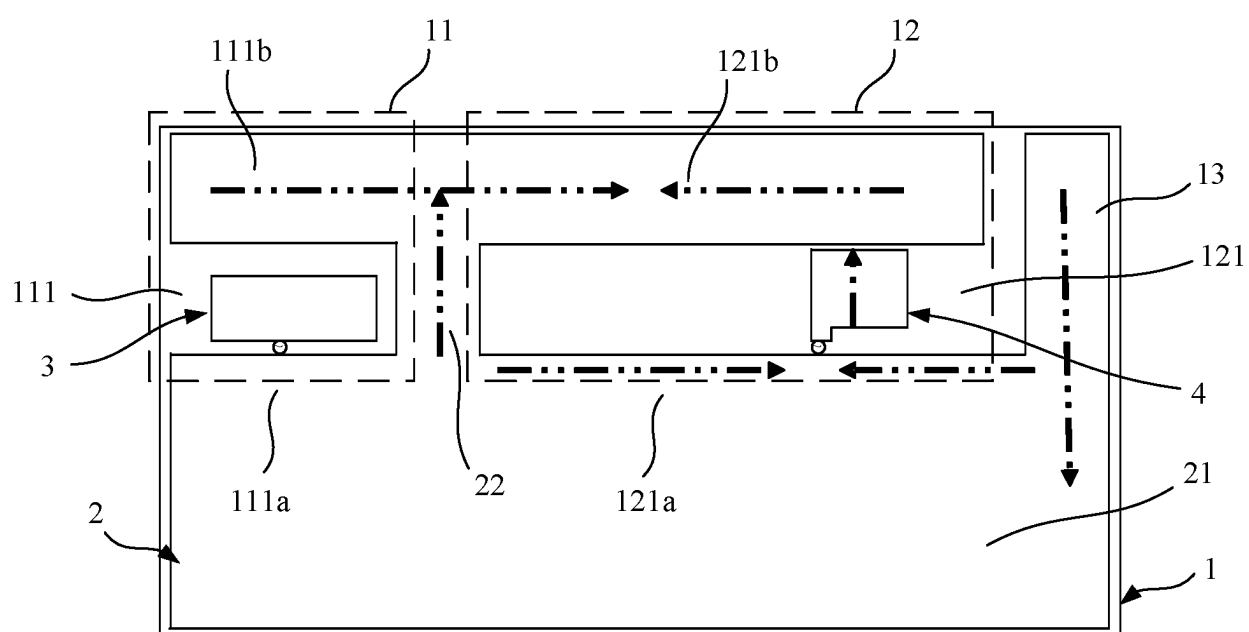


FIG. 13

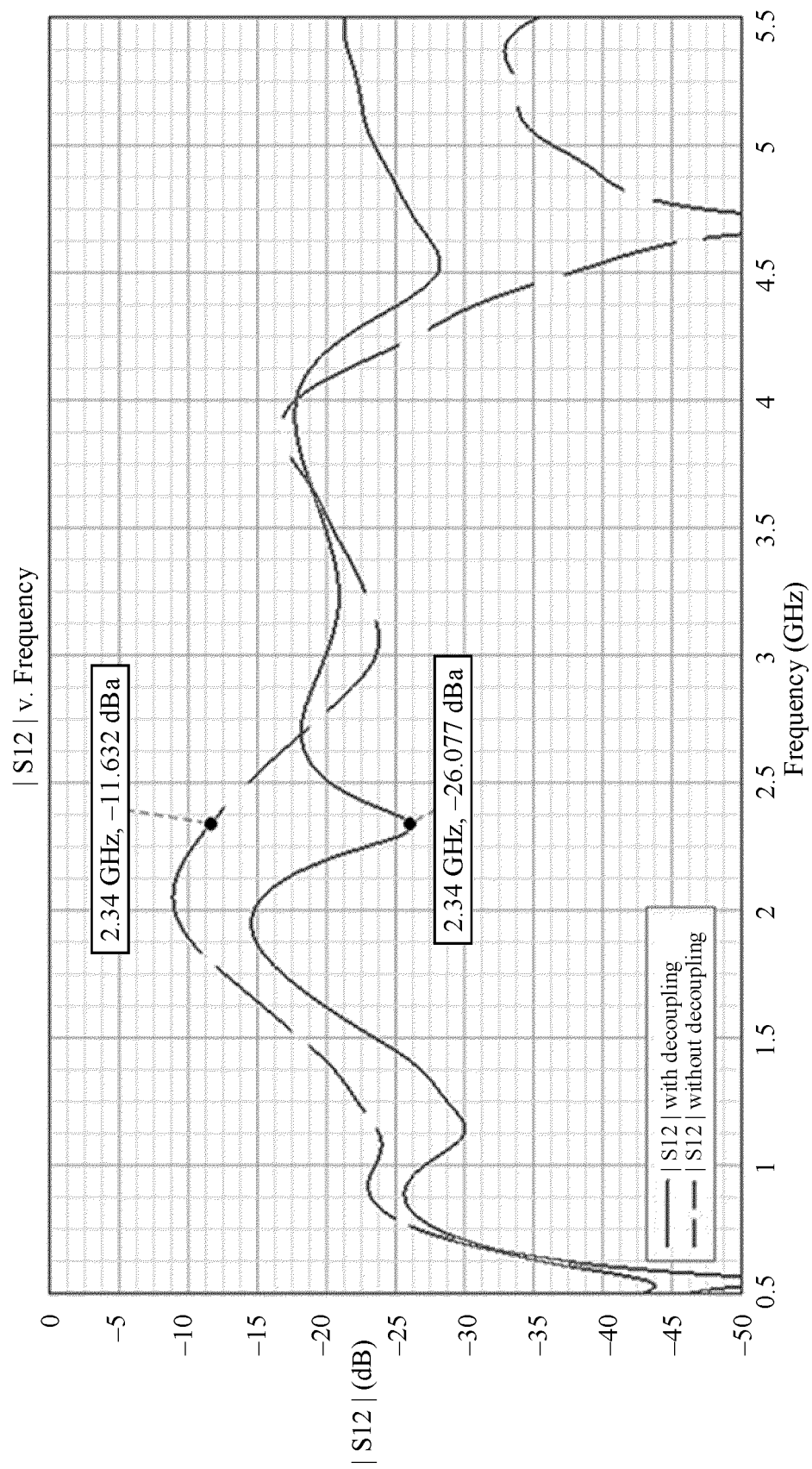


FIG. 14

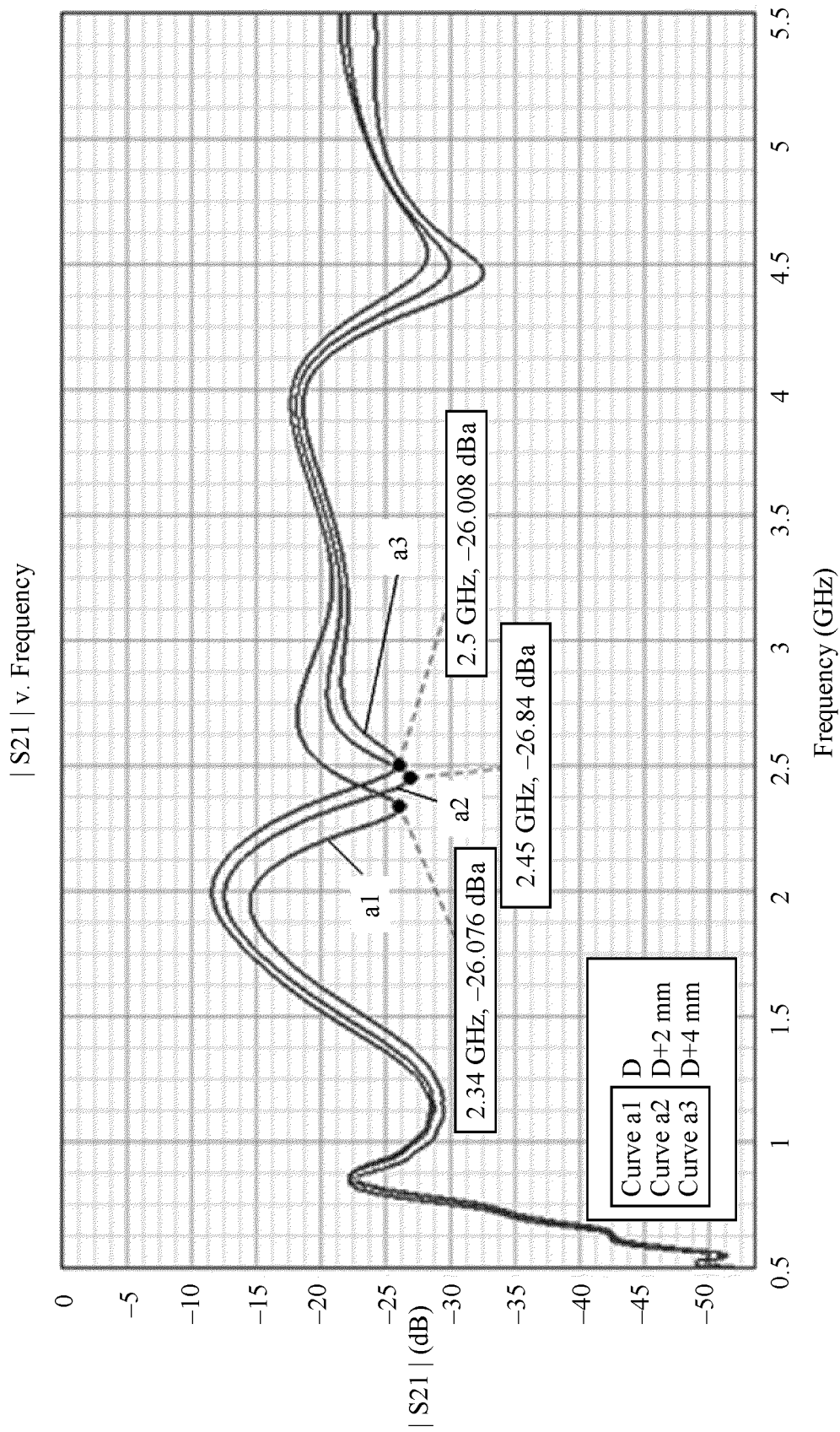


FIG. 15

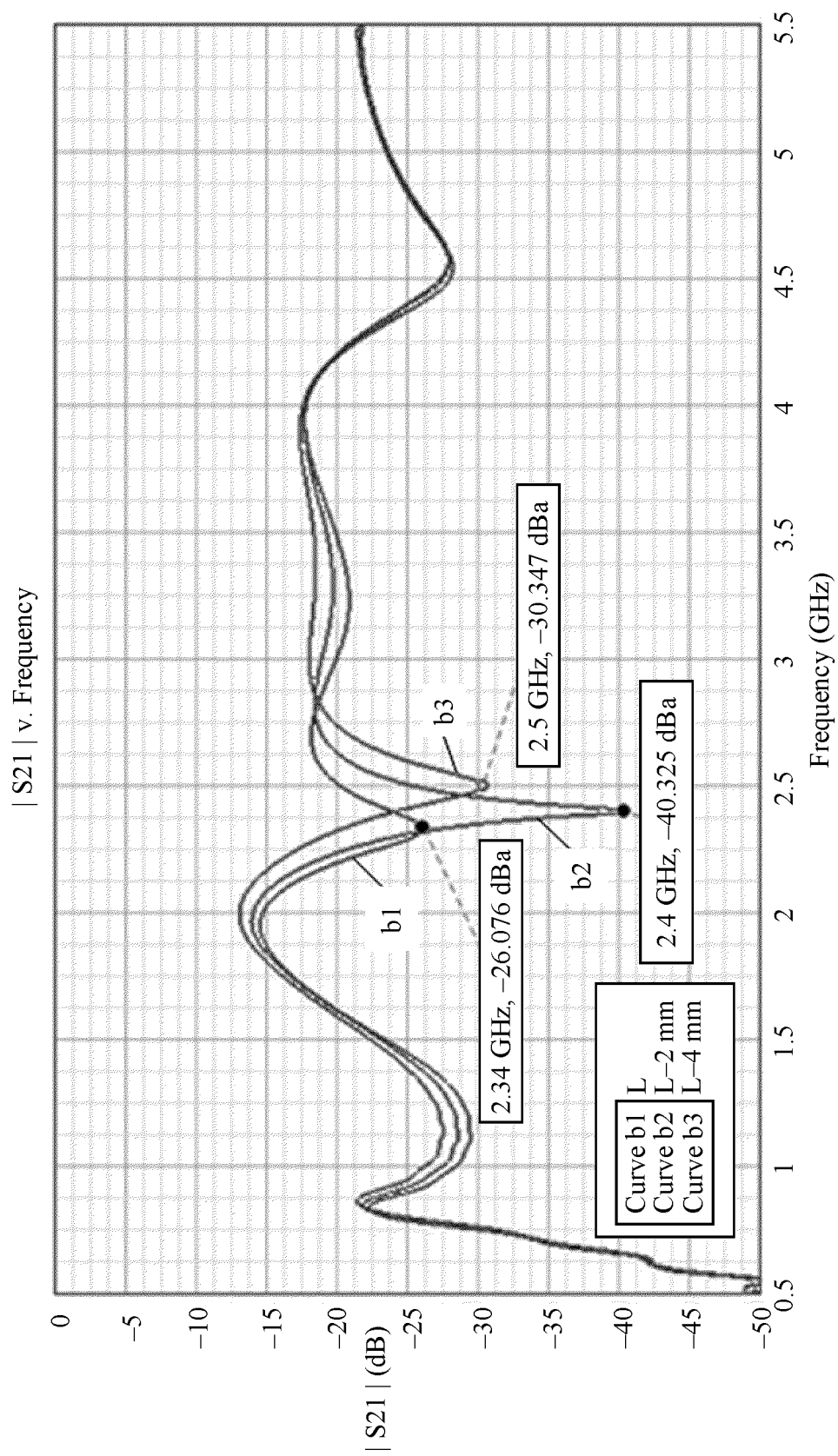


FIG. 16

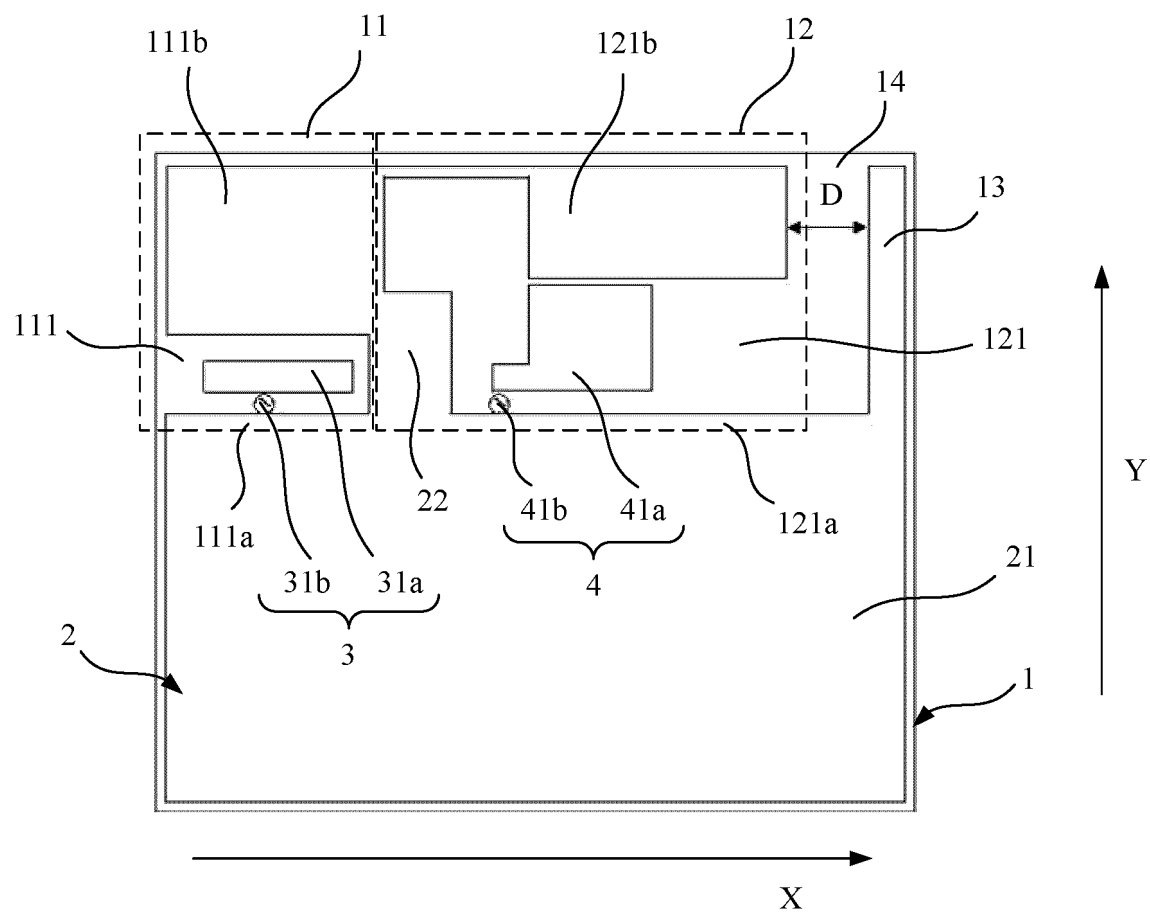


FIG. 17

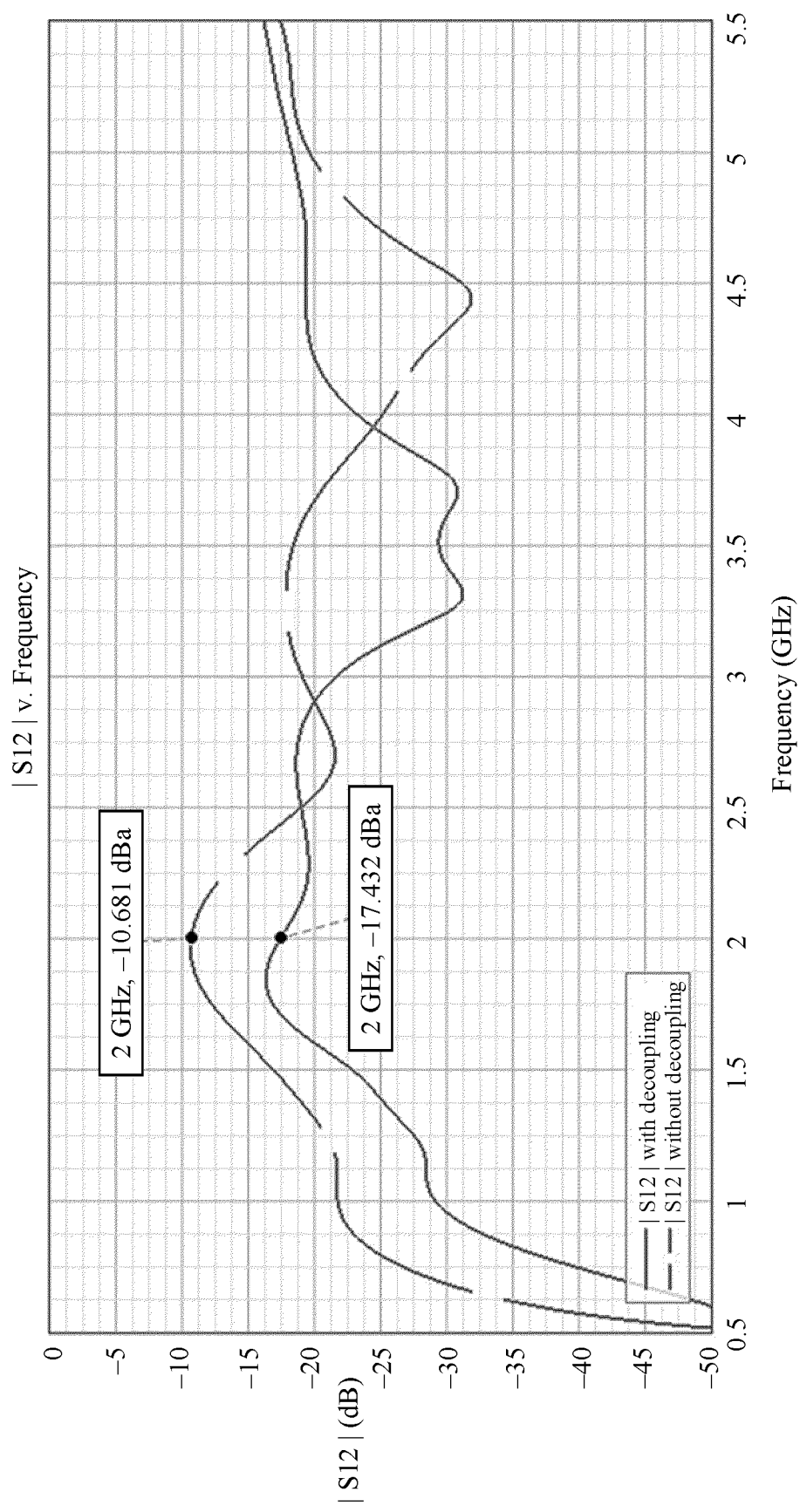


FIG. 18

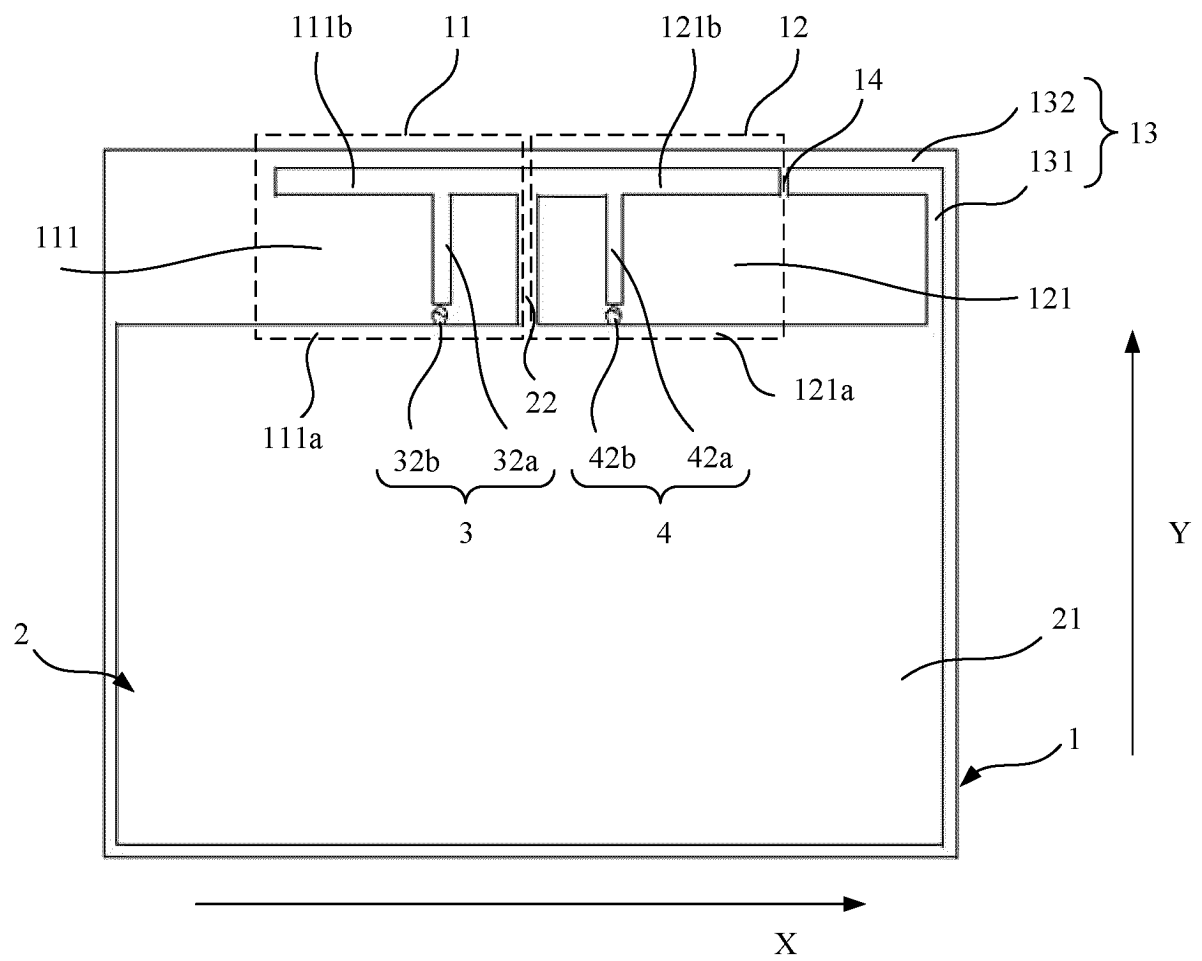


FIG. 19

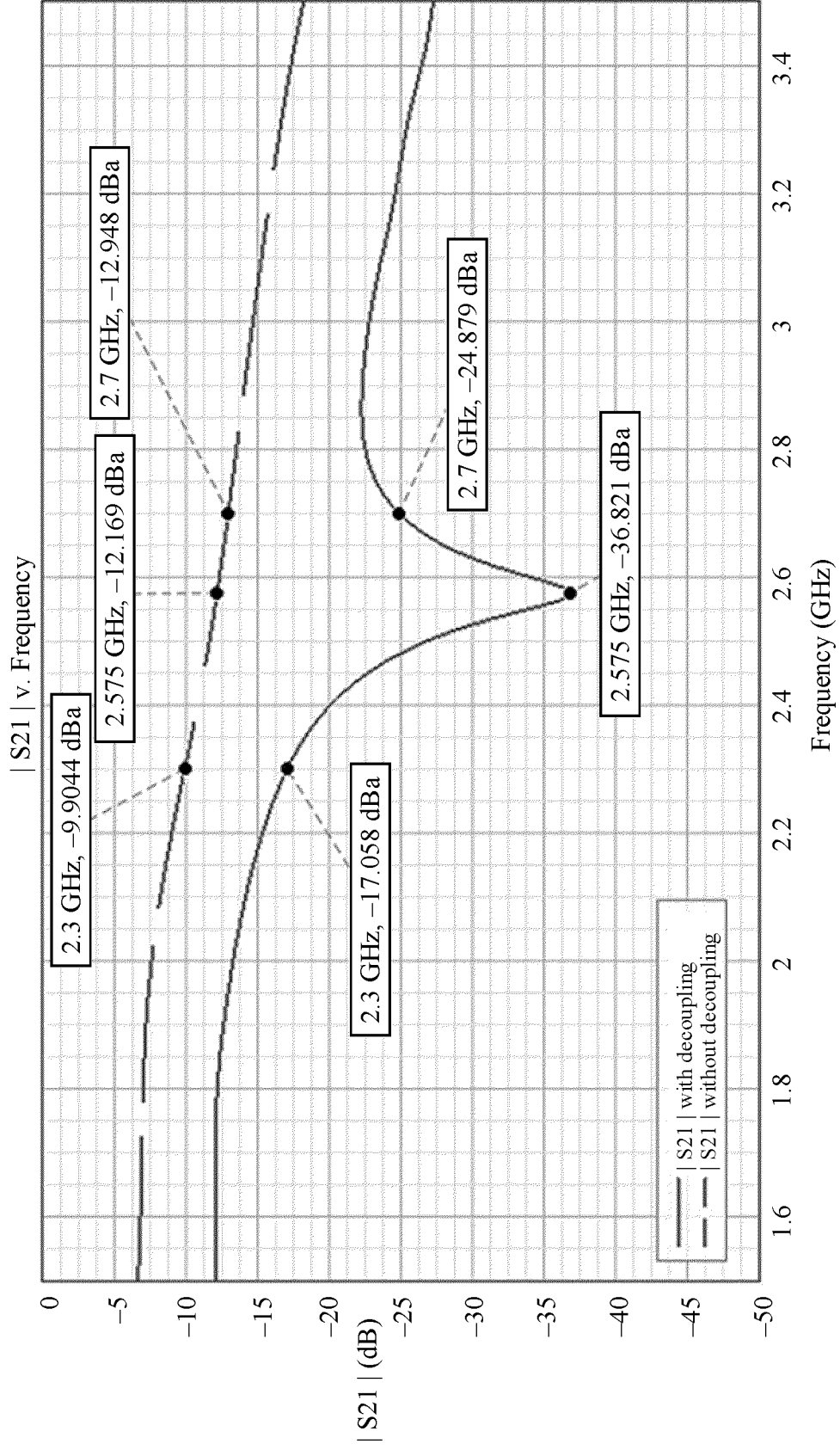


FIG. 20

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2023/110287

A. CLASSIFICATION OF SUBJECT MATTER

H01Q1/52(2006.01)i; H01Q5/10(2015.01)i; H01Q1/38(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, CNKI, IEEE, EPTXT, USTXT, WOTXT, VEN: 天线, 介质基板, 馈电, 半开槽, 半槽, 方向, 背离, 导电枝节, 开口, 缝隙, 电长度, 频段; antenna, substrate, base, plate, feeding, half-slot, direction, depart, conduct, branch, gap, electric, length, frequency, band

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 105762525 A (SOUTHEAST UNIVERSITY) 13 July 2016 (2016-07-13) description, paragraphs 4-23, and figure 1	1-20
A	CN 109509962 A (HUIZHOU SPEED WIRELESS TECHNOLOGY CO., LTD.) 22 March 2019 (2019-03-22) entire document	1-20
A	CN 110957576 A (UNIVERSITY OF ELECTRONIC SCIENCE AND TECHNOLOGY OF CHINA) 03 April 2020 (2020-04-03) entire document	1-20
A	CN 113540787 A (HUAWEI TECHNOLOGIES CO., LTD. et al.) 22 October 2021 (2021-10-22) entire document	1-20
A	CN 113851839 A (HONOR DEVICE CO., LTD.) 28 December 2021 (2021-12-28) entire document	1-20
A	US 6388631 B1 (HRL LABORATORIES, LLC; etc) 14 May 2002 (2002-05-14) entire document	1-20

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

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“O” document referring to an oral disclosure, use, exhibition or other means

“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

26 October 2023

Date of mailing of the international search report

07 November 2023

Name and mailing address of the ISA/CN

China National Intellectual Property Administration (ISA/
CN)
China No. 6, Xitucheng Road, Jimenqiao, Haidian District,
Beijing 100088

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2023/110287

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
CN 105762525 A	13 July 2016	None	
CN 109509962 A	22 March 2019	None	
CN 110957576 A	03 April 2020	None	
CN 113540787 A	22 October 2021	None	
CN 113851839 A	28 December 2021	None	
US 6388631 B1	14 May 2002	WO 02075841 A2	26 September 2002
		WO 02075841 A3	19 December 2002
		JP 2004532546 A	21 October 2004
		AU 2002250036 A1	03 October 2002
		TW 538560 B	21 June 2003
		EP 1371110 A2	17 December 2003

Form PCT/ISA/210 (patent family annex) (July 2022)

REFERENCES CITED IN THE DESCRIPTION

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- CN 202210970347 [0001]